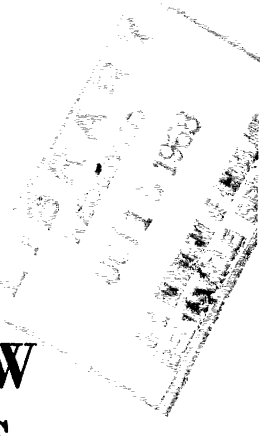

A COMPILATION OF DESCRIPTIONS OF NEW *PENICILLIUM* SPECIES

Agriculture Handbook No. 351

Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE

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By
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Research Plant Pathologist
Market Quality Research Division

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ALPHABETICAL LIST OF *PENICILLIUM* SPECIES

[Numbers refer to pages containing descriptions of *Penicillium* species]

A COMPILATION OF DESCRIPTIONS OF NEW *PENICILLIUM* SPECIES

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INTRODUCTION

The members of the genus *Penicillium* are important to man because of their role in decay processes, storage diseases of grains, industrial fermentations, production of antibiotics, and in the elaboration of aflatoxins.[1] Consequently, many research workers in plant pathology and related disciplines need to identify representatives of this genus.

Raper and Thom's "Manual of the Penicillia," [2] which describes or lists almost seven hundred species, was published in 1949. Since 1949, however, nearly one hundred penicillia have been described as new to science. In addition, descriptions of 13 species, mostly from relatively obscure publications that appeared before 1949 but not included in the "manual," have been found. One hundred and thirteen descriptions are included here.

The purpose of this compilation is to present these descriptions, plus an analytical key, so that those interested in identifying species of *Penicillium* not found in the "Manual of the Penicillia" will not have to search the literature for descriptions of them.

For descriptions of newly described penicillia, the card file of the National Fungus Collection and the Commonwealth Mycological Institute's "Index of Fungi" were the principal guides. Most of the references, however, to species described in Japan before 1949, but which do not appear in Raper and Thom's book, were found in Abe's monograph on the penicillia.[3]

Seventy-three of the original descriptions presented here were in English and thirty-nine were in other languages. I am responsible for all translations except for eight from the Japanese and three from the Russian (see Acknowledgments). In a number of cases, I translated the vernacular description instead of the Latin diagnosis, because the former presented a good deal more information.

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[1] HODGES, F. A. et al. MYCOTOXINS: AFLATOXINS ISOLATED FROM PENICILLIUM PUERULUM. Science 145: 1939. 1964.

KULIK, M. M., and HOLADAY, C. E. AFLATOXIN: A METABOLIC PRODUCT OF SEVERAL FUNGI. Mycopath, et Mycol. Appl. 30: 137–140. 1966.

[2] RAPER, H. B., and THOM. C. A MANUAL OF THE PENICILLIA. The Williams and Wilkins Co., Baltimore, 875 pp. 1949.

[3] ABE, S. STUDIES ON THE CLASSIFICATION OF THE PENICILLIA. Jour. Gen. Appl. Microbiol. 2: 1–193. Tokyo. 1956.

All descriptions represent exact copies or direct translations of the original articles, except for parenthetical remarks.

In constructing the key, my chief objective was to simplify searching for a description of a given species. Consequently, the key should be considered a means to achieve this end and not a phylogenetic treatment. It should also be emphasized that the key is not based on my study of the species described, nor is this compilation a mongraphic treatment or in any way a supplement to the "Manual of the Penicillia."

The colony characteristics used to construct the key, with a few exceptions, are based on growth on Czapek's solution agar; the exceptional media are noted.

The form used for citing the various journals is that used in the Commonwealth Mycological Institute's "Index of Fungi."

An asterisk (*) precedes the name of all taxa published without a Latin diagnosis, regardless of the year in which the description appeared.

ACKNOWLEDGMENTS

J. O. Legg, Agricultural Research Service, translated from the Russian, descriptions of the following fungi: *P. aromaticum* forma *microsporum*, *P. aspergilloides*, and *P. vitale*. N. Wakabayashi, Agricultural Research Service, translated from the Japanese, descriptions of the following fungi: *P. albo-simplex*, *P. echinosporum*, *P. luteocaeruleum*, *P. maltum*, *P. nopporoense*, *P. oligosporum*, *P. toxicarium*, and *P. velutinum*.

KEY TO *PENICILLIUM* SPECIES INCLUDED IN THIS COMPILATION

I. Penicilli usually monoverticillate, conidiophores generally unbranched.
  A. Cleistothecia or sclerotia produced.
    1. Cleistothecia produced.
      a. Parasitic on fresh water fishes.....*P. piscium.*
      b. Not parasitic on fresh water fishes.
        (1) Penicilli monoverticillate when present; sterigmata sometime appear directly from the mycelium; cleistothecia yellow-brown to brown; reverse red *P. oligosporum.*
        (2) Penicilli sometimes biverticillate; sterigmata do not appear directly from the mycelium; cleistothecia yellow; reverse not red.
          (a) Colonies velvety-tomentose, aerial hyphae slightly rose colored; asci 8-spored, ascospores 4.5μ to 5.0μ in long dimension, walls rough.....*P. liani.*
          (b) Colonies hardly subfloccose, aerial hyphae yellow; asci 6-spored, ascospores 2.5μ to 3.5μ in long dimension, with two soft crests.....*P. ucrainicum.*

(3) Penicilli strictly monoverticillate; sterigmata do not appear directly from the mycelium.
(a) Cleistothecia usually 150μ to 250μ in diameter, in pinkish cinnamon shades becoming brown in age; ascospores 3.0μ to 3.5μ $\times$ 2.5μ to 2.8μ *P. cinnamopurpureum* (*Eupenicillium cinnamopurpureum*).
(b) Cleistothecia 200μ to 300μ in diameter, yellow-orange when young but slowly darkening in age; ascospores 2.2μ to 2.7μ $\times$ 1.5μ to 2.0μ *P. hirayamae* (*Eupenicillium hirayamae*).

2. Sclerotia produced, no cleistothecia found.
a. Growth on Czapek's solution agar restricted, not more than 30 mm. in diameter after 10 to 12 days.
(1) Mycelium sparse.
(a) Colonies ochre, sclerotia ochre-yellow, chlamydospores produced; conidiophores dark; conidia smooth..... *P. macedonense.*
(b) Colonies near deep olive (R., pl. XL),[4] sclerotia honey yellow (R., pl. XXX) with age; no chlamydospores; conidiophores colorless or faintly pigmented..... *P. pinetorum.*
(2) Mycelium not sparse; sterigmata 6.0μ to 6.5μ long; conidia echinulate, spherical, 4.8μ to 5.5μ in diameter..... *P. silvaticum.*
b. Growth on Czapek's solution agar greater than 30 mm. in 10 to 12 days.
(1) Colonies at length gray-green, olivaceous-green, or grayish blue-green.
(a) Colonies white then gray-green; exudate abundant; sclerotia white to cream, length to 150μ *P. indicum.*
(b) Colonies blue-gray then olivaceous-green or gray-green; no exudate; sclerotia in shades of brown, length to 320μ..... *P. crocicola.*
(2) Colonies in other shades of green.
(a) Colonies in bright yellow-green shades; reverse pale yellow; sclerotia cinnamon or orange; up to 14 sterigmata per verticil..*P. thomii* var. *flavescens.*
(b) Colonies in green shades changing to light pinkish cinnamon with production of salmon-colored sclerotia; reverse light tan to light gray; up to nine sterigmata per verticil..... *P. yezoense.*

B. Neither cleistothecia nor sclerotia produced.
1. Reverse white or white-rose.
a. Reverse white; on sugar beet root extract agar the conidia are smooth-walled..... *P. kursanovii.*
b. Reverse white-rose; on sugar beet root extract agar the conidia are not smooth-walled.

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[4] R.= RIDGWAY, R. COLOR STANDARDS AND COLOR NOMENCLATURE. Washington, D.C. 1912.

(1) Conidia up to 4μ in diameter, slightly roughened
P. cinereoatrum.

(2) Conidia up to 2.8μ in diameter, almost warty
P. cremeogriseum.

2. Reverse neither white nor white-rose.
   a. Blue pigment dispersed in cytoplasm of hyphae, especially prevalent in sterigmata and conidia (on nutritive agar) ..... *P. griseo-azureum.*
   b. Intracellular blue pigment absent.
      (1) Penicilli variable, sometimes biverticillate-asymmetric.
         (a) Colonies white then greenish blue; reverse straw yellow then yellow-cinnamon (on wort agar)
         P. vitale.
         (b) Colonies yellow; reverse bright orange and eventually almost scarlet.... *P. luteo-aurantium.*
      (2) Penicilli consistently monoverticillate.
         (a) Diameter of colonies on Czapek's agar not more than 35 mm. in 10 to 12 days.
            1′ Colonies uncolored then ash green; reverse uncolored then golden; on sugar beet root extract agar: sterigmata 12μ to 19μ long..... *P. bilaji.*
            2′ Colonies not as above.
               a′ Colonies funiculose.
                  1″ Reverse in olive shades; sterigmata 10μ to 16μ long, two to three per verticil; conidia elliptical, faintly spinulose, 3μ to 4.5μ in diameter..... *P. ellipticum.*
                  2″ Reverse yellow; sterigmata 5μ to 7μ or occasionally 9.3μ long, 6 to 15 per verticil; conidia globose to subglobose, echinulate or verruculose, diameter to 2.8μ..... *P. lilacinoechinulatum.*
                  3″ Reverse cream colored (on malt agar); sterigmata 9μ to 12μ long, three to nine per verticil; conidia elliptical, smooth-walled, 2μ to 3μ in diameter.... *P. resedanum.*
               b′ Colonies floccose; reverse occasionally purple or dark purple in part; sterigmata 12μ long; conidia round, smooth, 1.5μ to 2.5μ in diameter..... *P. albo-simplex.*
               c′ Colonies tomentose; reverse clear yellow-olivaceous or rose; on sugar beet root extract agar: conidiophores slightly roughened; sterigmata 6.5μ to 8μ long, conidia globose, smooth, 2.5μ to 3.5μ in diameter
               P. glaucolanosum.
               d′ Colonies submerged; reverse uncolored; conidia spiny, 3.5μ to 5.4μ in diameter
               P. montanense.

e′ Colonies velvety.
1″ Colonies in yellow-green shades.
a″ Reverse colorless or slightly green; exudate limited and hyaline; sterigmata 6.8μ to 9.3μ or occasionally 13.7μ long, 7 to 14 per verticil; conidia to 3.1μ in diameter..*P. atrovirens* (Syn. *P. decumbens* var. *atrovirens*).
b″ Reverse green-yellow; exudate lacking or limited and pale yellow; sterigmata 6.8μ to 8.7μ long, 5 to 12 per verticil; conidia 1.5μ to 2.3μ in diameter
P. aeneum (Syn. *P. citreoviride* var. *aeneum*).
c″ Reverse colorless; exudate lacking; sterigmata 6.2μ to 7.5μ long, three to eight per verticil; conidia 3.7μ to 6.0μ in diameter.....*P. fuscoflavum.*
2″ Colonies in blue-green shades, reverse colorless to drab; exudate absent; sterigmata 10μ to 13.2μ long; conidia 2.5μ to 3.4μ in diameter
P. fellutanum var. *nigrocastaneum.*
3″ Colonies in some other shades of green.
a″ Colonies olive-green, reverse colorless or yellow; sterigmata 5.6μ to 7.8μ long, three to five per verticil; condia pyriform or cylindrical, 2.2μ to 2.8μ in diameter.....*P. ramusculum.*
b″ Colonies olivaceous-green, reverse dark olivaceous to dark brown; sterigmata 14μ to 23μ long, five to nine per verticil; conidia ellipsoid or subglobose, 4.3μ to 12.5μ in diameter....*P. taxi.*
4″ Colonies yellow, reverse yellow; conidia 2μ to 2.5μ in diameter.....*P. toxicarium.*
(b) Diameter of colonies on Czapek's agar more than 35 mm. in 10 to 12 days.
1′ Colonies floccose, reverse pinkish-buff or cinnamon buff; sterigmata 10μ to 15μ long; condida elliptical, 2.5μ to 3.5μ in diameter
P. parallelosporum.
2′ Colonies not floccose.
a′ Velvety in marginal area, funiculose in central area; slate-olive; conidiophores spinulose, sometines ramigenous....*P. spinulo-ramigenum.*
b′ Colonies not as above.
1″ Colonies extremely thin, transparent
P. griseolum.
2″ Colonies not extremely thin nor transparent.
a″ Reverse colorless to drab; conidiophores punctate; sterigmata 14μ to 18μ long, five to eight per verticil; conidia echinulate or granular

P. abeanum (Syn. *P. trzebinskii* var. *magnum*).

b'' Reverse yellow-green or vinaceous, becoming olivaceous-black; conidiophores punctate or small-granular; sterigmata 8.7μ to 12.5μ long, 5 to 12 per verticil; conidia echinulate..... *P. trzebinskianum.*

c'' Reverse green to purple; conidiophores smooth or nearly so, ramigenous; conidia smooth or nearly so *P. charlesii* var. *rapidum.*

d'' Reverse uncolored or in shades of brown; odor very strong resembling apples; conidiophores and conidia rough *P. odoratum.*

e'' Reverse in orange or orange-cinnamon shades becoming reddish brown; conidiophores generally arise from substrate; conidia smooth-walled... *P. adametzioides.*

II. Penicilli once or more branched below the level of the sterigmata and not symmetrical.

A. Penicilli usually divaricate.

1. Colonies white becoming gray, reverse white at first then orange; on sugar beet root extract agar: sterigmata 6μ long, conidia 1.8μ to 2.3μ in diameter..... *P. albocinerascens.*

2. Colonies not as above.

a. Growth on Czapek's agar limited.

(1) Colonies lanose, green, reverse pale vinaceous fawn (R., pl. 40); sterigmata 7.2μ to 9.8μ long; conidia globose to oval..... *P. allahabadense.*

(2) Colonies velutinous or subfloccose, in olive or yellow-green shades, reverse in reddish shades; sterigmata 8.5μ to 12.5μ long; conidia ovate or subglobose *P. echinulonalgiovense.*

(3) Colonies loosely tomentose, barely pallid Quaker drab (R., pl. 51), reverse white at first then white or primrose yellow (R., pl. 30); sterigmata 10μ to 12μ long, conidia spherical..... *P. nopporoense.*

(4) Colonies tomentose, gray-olivaceous, reverse orange; on sugar beet root extract agar: sterigmata 7.0μ long, conidia ellipsoid..... *P. glaucocinerascens.*

(5) Colonies thick velvety, bluish gray-green becoming almost pure gray, reverse becoming very dark brownish purple; sterigmata 10μ long; conidia globose to subglobose..... *P. griseopurpureum.*

(6) Colonies finely wooly to floccose, yellow-green to green, reverse pale yellow; sterigmata 5μ long; conidia round..... *P. impar.*

b. Growth on Czapek's agar spreading.

(1) Colonies thin, close-textured, olive-buff to deep olive (R., pl. 45), reverse olive-ochre to yellow-olive near Prout's brown (R., pl. 15); conidia 5μ to 7μ, coarsely echinulate..... *P. megasporum.*

(2) Colonies not as above.
(a) Colonies velvety.
1′ Colonies gray-green, reverse yellow or dark maroon; conidiophores slightly roughened; conidia subglobose or elliptical....*P. brasilianum.*
2′ Colonies dark bluish green, reverse somewhat greenish-yellow; conidiophores very rough; conidia globose.....*P. radulatum.*
(b) Colonies thick velvety to matted floccose, bluish gray-green becoming grayer and duller, reverse at first buff to dull pink, becoming pinkish brown.....*P. novae-caledoniae.*
(c) Colonies not as above.
1′ Colonies subfloccose, dark dull green, reverse pale yellow becoming pink; conidia globose to subglobose, aculeate
P. nigricans var. *sulfuratum.*
2′ Colonies floccose-funiculose, white, reverse deep yellow to bright orange; conidia ovate to lemon shaped, smooth.....*P. alboaurantium.*
3′ On wort agar; colonies lanose, bluish gray-green, reverse brick red; conidia oval at first, then subglobose, often apiculate, smooth; parasitic on the bamboo rat.....*P. marneffei.*

B. Penicilli not usually divaricate.
1. Cleistothecia or sclerotia produced.
a. Cleistothecia produced.
(1) Colony reverse in deep reddish shades.
(a) Cleistothecia 190μ to 280μ in diameter; asci up to 10μ long; ascospores 4.2μ to 5.0μ x 3.0μ to 3.2μ.....*P. kewense.*
(b) Cleistothecia up to 500μ in diameter; asci up to 15μ long; ascospores 5.5μ to 6.5μ x 3.5μ to 4.5μ.....*P. lapidosum* (*Eupenicillium lapidosum*).
(2) Colony reverse in yellow shades
P. ochrosalmoneum (*Eupenicillium ochrosalmoneum*).
b. Sclerotia produced.
(1) Sclerotia cream or lemon colored at first, later becoming gray-hazel, usually irregular in shape, 180μ to 430μ $\times$ 110μ to 250μ, rough; penicilli variable, sometimes divaricate; conidia oval to subglobose, 1.9μ to 2.4μ $\times$ 2.4μ to 2.8μ
P. pedemontanum.
(2) Sclerotia brown to dark brown, globose to ellipsoid, 170μ to 380μ $\times$ 160μ to 320μ, somewhat rough; conidia elliptical, 3μ to 4μ $\times$ 4μ to 6μ
P. sclerotigenum.
2. Cleistothecia or sclerotia not produced.
a. Colonies are fasiculate or coremiform.
(1) Coremia *Isaria*-like, up to 15 cm. long, colonies attain a diameter of about 40 mm. after 14 days, reverse yellow; conidia elliptical, 3μ to 3.8μ in diameter.....*P. isariiforme.*

(2) Conidiophores solitary or in fascicles for part of their lengths, up to 0.5 mm. long; colonies attain a diameter of 30 to 35 mm. after 14 days, reverse dull brown; conidia ellipsoid to round, 2.5μ to 3.0μ in diameter..... *P. maltum.*

(3) Typically or slightly fasciculate; conidiophores less than 0.5 mm. long; colonies attain a diameter of 30 to 47 mm. after 10 to 12 days; conidia globose to subglobose, 2.5μ to 3.8μ in diameter *P. viridicyclopium.*

(4) Conidiophores in coremia (clavae), 5 mm. long; conidia thick-walled, smooth, 2μ to 3μ in diameter; may be associated with insects *P. (Cordyceps) albellum.*

b. Colonies not fasciculate or coremiform.

(1) Penicilli variable, sometimes monoverticillate

(a) Colonies green, reverse yellow then red-brown; metulae mostly 15μ long; sterigmata 8μ to 12μ long..... *P. velutinum.*

(b) Colonies ash-green, reverse intense yellow or brick red; metulae 10μ to 17.5μ long; sterigmata 3.5μ to 4.5μ long..... *P. botryosum.*

(c) Colonies deep dull yellow-green to Danube green (R., pl. 32), reverse greenish black tinged with pale yellow; metulae 8μ to 13μ long; sterigmata 10μ to 16μ long..... *P. phialosporum.*

(d) Colonies at first pale yellow, later pale bluish green, reverse dull brown with intense yellow edge; sterigmata 7μ to 9μ long..... *P. raperi.*

(2) Penicilli consistently biverticillate-asymmetric.

(a) Colonies not growing at 25° C., optimum development at 40° to 45° C.; ascocarps abundantly produced..... *P. emersonii.*

(b) Colonies grow restrictedly at 25° C.; no ascocarps produced.

1′ Metulae 7μ to 12μ long; conidia globose.

a′ Colonies velvety, in shades of dark gray or grayish blue..... *P. atrovenetum.*

b′ On Sabouraud's agar: colonies thin, blue-green then grayish red..... *P. camerunense.*

2′ Metulae longer than 12μ, but if shorter, the colonies are not velvety nor thin; conidia not globose.

a′ Colonies full of mounds, rosy then brown colored; on sugar beet root extract agar: conidia lemon-shaped then ellipsoid-globose *P. arenicola.*

b′ Colonies velvety to somewhat velvety.

1″ Reverse deep yellow-brown, metulae 12μ to 20μ long, conidia cylindrical *P. cylindrosporum.*

2″ Reverse at first colorless or pale yellow, then pale olive; metulae 12.5μ to 18.7μ long; conidia elliptical to subglobose, smooth or nearly so.....*P. corylophiloides.*

c′ Colonies floccose or tomentose.

1″ Reverse bright yellow; conidia elliptical and spiny.....*P. echinosporum.*

2″ Reverse white then milky yellow; on sugar beet root extract agar: conidia lemon-shaped, very slightly roughened *P. pidoplitschkanum.*

(c) Colonies spreading broadly at 25° C., no ascocarps produced.

1′ On wort agar: colonies orange colored then dirty crimson; mature conidiophores light brown with traces of orange tones.....*P. aspergilloides.*

2′ Colonies not as above.

a′ Colonies showing some shade of green.

1″ Conidia smooth or nearly so.

a″ Conidiophores smooth; metulae 10μ to 16μ long; conidia mostly ovoid to elongate in tangled chains *P. japonicum* (Syn. *P. digitatum* var. *latum*)

b″ Conidiophores granular; metulae 10.6μ to 13.6μ long; conidia elliptical to ovate in loosely columnar or tangled chains.....*P. pseudocasei.*

c″ Conidiophores smooth or nearly so; metulae 12.5μ to 25μ long; conidia globose to subglobose in columnar or loosely tangled chains.....*P. citreovirens.*

2″ Conidia not smooth.

a″ Reverse of colonies uncolored.

1‴ Conidiophores sometimes branched below the level of the metulae; metulae 11μ to 13μ long; conidia 2.2μ to 2.6μ in long dimension *P. kojigenum.*

2‴ Conidiophores not branched below the level of the metulae; metulae 12μ to 16μ long; conidia 3μ to 3.2μ in long dimension.....*P. coeruleoviride.*

b″ Reverse of colonies peach colored; conidiophores not branched below the level of the metulae; conidia finely roughened in columnar chains..*P. madriti.*

b′ Colonies not showing shades of green.

1″ Colonies velvety.

a″ Reverse cherry-yellow; conidia usually not formed on Czapek's agar *P. amagasakiense.*

b'' Reverse yellow or light brown; conidia abundantly produced on Czapek's agar.....*P. brunneostoloniferum.*

2'' Colonies floccose-funiculose; reverse orange then brownish black.....*P. aurantiacum.*

III. Penicilli characteristically biverticillate and symmetric.

A. Growth on Czapek's agar restricted.

1. Penicilli symmetric but not characteristic of the Biverticillata-Symmetrica; conidia globose.....*P. asperosporum.*

2. Penicilli characteristic of the Biverticillata-Symmetrica.

a. Conidia not globose.

(1) Reverse dark olivaceous becoming black with age; metulae 6.3μ to 8.6μ long; conidia elliptical to cylindrical and stuck together with mucilage (penicilli variable, sometimes asymmetric) *P. aspergilliforme.*

(2) Reverse orange, orange-red, or orange-brown; metulae 10.6μ to 17.5μ long; conidia long-elliptical and dry.....*P. concavorugulosum.*

(3) Reverse salmon to purple but sometimes brownish; metulae 9.5μ to 14μ long; conidia lemon-shaped or elliptical, dry (penicilli variable, sometimes monoverticillate).....*P. proteolyticum.*

b. Conidia globose to subglobose; reverse in shades of orange to orange-brown; metulae 6μ to 7μ long (colonies sometimes spreading on Czapek's agar, penicilli variable, sometimes asymmetric).....*P. rubicundum.*

B. Growth on Czapek's agar spreading broadly.

1. Sclerotia produced.....*P. coralligerum.*

2. Sclerotia not produced.

a. Colonies blue-green to blue to gray, reverse yellow then blue-green with bright yellow borders; conidia oval and smooth.....*P. luteocaeruleum.*

b. Colonies not as above.

(1) Colonies velvety.

(a) Reverse in dull yellow or olive shades; conidiophores slightly roughened; conidia granular or verruculose.....*P. estinogenum.*

(b) Reverse in greenish shades; conidiophores typically granular; conidia slightly roughened *P. paraherquei.*

(2) Colonies not velvety.

(a) Colonies subfloccose or slightly funiculose; reverse vinaceous or in reddish shades; conidia typically ovate to subglobose with one end apiculate, 3μ to 4μ in diameter....*P. aculeatum* var. *apiculatum.*

(b) Colonies tufty but tending to become fasciculate; reverse yellow-orange; conidia ellipsoid to subglobose, 3.2μ to 3.5μ in diameter...*P. brunneum.*

IV. Penicilli polyverticillate.....*P. canadense.*

V. Colonies represent mutants or new varieties of previously described species.
  A. Ultraviolet radiation-induced mutants.
    1. Colonies cinnamon colored instead of the normal green of *P. chrysogenum*.....*P. chrysogenum* mutant *fulvescens*.
    2. Colonies white instead of the normal green of *P. claviforme*
P. claviforme mutant *candicans*.
    3. Colonies olive instead of the normal green of *P. claviforme*
P. claviforme mutant *olivicolor*.
  B. Naturally occurring varieties (except for "1." which is a "forma").
    1. Colonies resemble *P. aromaticum* except for the small size of the conidia; 2.8μ to 3.0μ in diameter
P. aromaticum forma *microsporum*.
    2. Colonies resemble *P. casei* except for the spinulose conidia, compact penicilli, and the milky color of the colony reverse.....*P. casei* var. *compactum*.
    3. Colonies resemble *P. crustosum* except that the conidia are markedly spinulose....*P. crustosum* var. *spinulosporum*.
    4. Colonies resemble *P. cyclopium* except for the complete absence of conidial pigment.....*P. cyclopium* var. *album*.
    5. Colonies resemble *P. italicum* except for the complete absence of color.....*P. italicum* var. *album*.
    6. Colonies resemble *P. meleagrinum* except for the size of conidia (2.1μ to 3.0μ $\times$ 1.7μ to 2.6μ), early dull green, and the longer metulae (9.3μ to 18.7μ) and branches (9.3μ to 31.0μ).....*P. meleagrinum* var. *viridiflavum*.
    7. Colonies resemble *P. palitans* except for the production of conspicuously echinulate or verruculose conidia and the usual production of typically dark yellow-green shades.....*P. palitans* var. *echinoconidium*.
    8. Colonies resemble *P. roqueforti* except for the delicately echinulate or verruculose conidia, punctate or small-granular conidiophores, branches, and metulae, the pale pink colony reverse, and the absence of an arachnoid margin.....*P. roqueforti* var. *punctatum*.

DESCRIPTIONS OF *PENICILLIUM* SPECIES

Penicillium abeanum G. Smith (Syn. *P. trzebinskii* Zaleski var. *magnum* Abe), Trans. Brit. Mycol. Soc. 46:333. 1963.

"Colonies on Czapek agar growing rapidly, with very irregular outline to the sporing areas and with broad, but thin, white margin; reverse uncoloured; penicilli strictly monoverticillate; conidiophores smooth or very delicately roughened, 2.5–3.0μ diam., slightly swollen at the tip; phialides 8–15$\times$3.0–3.5μ; conidia globose to subglobose, rough, 4–5μ in long axis, in very long, roughly parallel chains.

"This fungus is not closely related to *P. trzebinskii*, and, since *magnum* is not a suitable specific epithet, a new name is proposed."

**Penicillium aculeatum* Raper and Fennell var. *apiculatum* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 124. 1956.

"Colonies on Czapek agar grow rather rapidly, about 40 to 50 mm. in 10 to 12 days at 25° C., consisting of a comparatively thin basal felt bearing crowded conidial structures, some strains subfloccose, others slightly funiculose, often with a vinaceous or pinkish cast from a limited overgrowth of red-pigmented hyphae, near Russet Vinaceous, Peach Red, Light Orange or Flesh Pink shades, with a yellow or light pink margin, 1.5 to 2.5 mm. wide, conidial areas in bright or dark yellow green shades near Civette Green, Cedar, Dark Yellowish Green or Dull Blackish Green, becoming Olivaceous Black with age; exudate limited and pale pink or lacking; odor almost lacking; reverse in vinaceous or reddish shades, becoming near Brick Red, Pompeian Red or Morrocco Red, with surrounding agar colorless or becoming pale similar shades; conidiophores arising from the substratum, basal felt or aerial hyphae, variable in length, commonly up to 30–60 or 200μ in length by 2.3–3.3μ in diameter, with smooth or slightly granular walls, apices up to 3.7–4.7μ in diameter; penicilli typically biverticillate and symmetrical, definitely inflated and suggestively divaricate, usually consisting of a single verticil of 6 to 10 to 12 metulae, each terminating in verticils of 5 to 7 or 8 sterigmata; metulae mostly 9.3–11.3–12.6μ by 2.3–3.3μ; sterigmata loosely compact or somewhat divergent, mostly 9.3–11.0 or 13.1μ by 2.2–3.1μ, lanceolate in form, characteristically tapered; conidia typically ovate to subglobose with one end apiculate, mostly 3.0–3.7 or 4.0μ by 1.7–3.2μ, with walls conspicuously echinulate or verruculose; conidial chains usually loosely parallel or tangled, up to 30–80μ in length; and conidia showing conspicuously echinulate or verruculose walls in electron microscopy.

"Colonies on steep agar grow rather rapidly, 49 to 56 mm. in 10 to 12 days at 25° C; the other characters are as described above, and sometimes the colony surface has a volcanic appearance.

"These strains differ markedly from *P. verruculosun* Pyronel primarily in the production of a strongly reddish color in the reverse.

"They differ markedly from the description of *P. aculeatum* Raper and Fennell primarily in the rather spreading growth, and in the typically ovate conidia with one end apiculate."

NOTE: "*P. aculeatum* Raper and Fennell var. *apiculatum* Abe, not separable from *P. aculeatum.*" G. Smith, Trans. Brit. Mycol. Soc. 46: 332. 1963.

**Penicillium adametzioides* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 68. 1956.

"Colonies on Czapek agar are rather rapidly spreading, 33 to 39 mm. in 10 to 12 days at 25° C; typically velvety or funiculose, with a white margin 1.0 to 1.5 mm. wide and thin or slightly funiculose; smooth or sulcate, sometimes radially furrowed; colony depth 500–800μ in the central area; sporulating throughout in pale yellow green near Greenish Glaucous Blue in the marginal area and Pea Green

in the central area, becoming Sage Green or Pea Green; exudate limited or abundant, Sulphur or Aniline Yellow; reverse in orange or orange cinnamon shades, becoming reddish brown, Pale Vinaceous in Vinaceous Tawny, becoming Xanthin Orange or Pale Green Yellow; conidiophores generally arising from the substratum, sometimes from hyphae, short, commonly 30–120μ by 1.8–3.1μ, with apices enlarged 3.1–6.2μ in diameter, with smooth walls or nearly so; penicilli strictly monoverticillate, comparatively short; sterigmata usually compact or somewhat divergent, crowded verticils, numbering about 6 to 10, mostly 8.7–10.6 or rarely 15.6μ by 1.8–2.5μ, acute type with smooth walls or nearly so; conidia elliptical to subglobose, 2.3–3.3μ by 1.5–2.5μ, smooth walled or nearly so in optical and electron microscopy; and chains of conidia tangled, up to 30–90μ in length.

"Colonies on steep agar rather rapidly spreading, 37 to 39 mm. in 10 to 12 days at 25° C., heavily sporulating throughout in near Tea Green shades; reverse strongly brown-red shades, with surrounding agar in reddish brown shades; the other characters as on Czapek.

"This strain differs from former descriptions of *P. adametzi* Zaleski in the rather rapidly spreading growth, in the elliptical conidia with smooth walls or nearly so, in the sterigmata somewhat longer than *P. adametzi*, and in the velvety character of its colonies.

"The correct placement of the species remains in doubt, but it appears to be most satisfactorily assignable to (the *P. adametzi* series of) the Monoverticillata according to Raper and Thom's classification."

NOTE: G. Smith (Trans. Brit. Mycol. Soc. 46: 335. 1963) provided a Latin diagnosis for this species, the complete name of which is now *P. adametzioides* Abe ex G. Smith.

Penicillium aeneum G. Smith (Syn. *P. citreoviride* Biourge var. *aeneum* Abe), Trans. Brit. Mycol. Soc. 46: 334. 1963.

"Colonies on Czapek agar growing slowly, very bluish grey-green, with a narrow, slightly yellowish, fimbriate margin, velvety but somewhat heaped in the centre; reverse dull yellow or developing a greenish cast which might be termed bronze; penicilli strictly monoverticillate; conidiophores smooth, very slender, only 1.5μ diam.; phialides 6–7×2.0–2.5μ; conidia globose, rough, 1.7–2.0μ diam., in chains which are loosely parallel to tangled.

"This species differs in too many respects from *P. citreoviride* to be regarded as a variety of it."

Penicillium (*Cordyceps*) *albellum* (Massee) Petch, Trans. Brit. Mycol. Soc. 16: 210. 1932.

"The clavae are about 5 mm. high, terete, smooth, about 200μ dm below, attenuated upwards to 150μ dm, and then expanding into a long clavate head, about 360μ dm. They are composed of parallel

agglutinated hyphae which separate into conidiophores above, with a few outlying conidiophores on the upper part of the stalk. The conidiophores are penicillioid, hyaline, with a stalk 2μ dm, either branched above, the branches terminating in cylindric or clavate phialides, 7–10×2–2.5μ, or unbranched, bearing three similar phialides at the apex, each phialide bearing a chain of conidia. The conidia are hyaline, thickwalled, smooth, globose, 2–3μ dm, or broadly oval, 2.5–3.5×2–2.5μ, catenulate, united by a distinct isthmus about 1μ long. The conidiophores are closely packed together in the head, so that the head is compact, not loose."

NOTE: This description is based on a specimen that was on a grasshopper. Petch doubts "whether the fungus really grew on the insect."

Penicillium alboaurantium G. Smith (as "*albo-aurantium*"), Trans. Brit. Mycol. Soc. 40: 484. 1957.

"On Czapek agar, malt agar, or potato agar grows somewhat slowly, about 20 mm. diam. in 7 days at 24° C., but eventually spreads broadly floccose funiculose, fairly thick in the centre and thinning towards the margin, persistently white but sometimes appearing yellowish from the bright reverse colour showing through; reverse deep yellow to bright orange; penicillus typically divaricate, sometimes consisting of a fairly compact, thrice verticillate, terminal structure, with numerous metulae and phialides, but often very irregular and loose in structure; conidiophores smooth, very variable in length, 30–400μ, and 2–2.5μ diam.; metulae mostly 4–6×2–2.2μ, but occasionally up to 10μ long; phialides in most penicilli very regular in size, 5×2μ, but sometimes 7–8μ long, tapering fairly abruptly at the tip; conidia ovate to lemon-shaped, smooth, 2.3–2.5, rarely 3, ×1.5–1.8μ, in chains which soon become much tangled.

"This species, on account of the structure of the penicilli and the texture of the colonies, is to be classed in the Asymmerica-Divaricata, and . . . it will have to be placed, for the time being, in the *P. lilacinum* series, simply on account of its total lack of green color. However, it shows little similarity to *P. lilacinum* Thom or *P. humuli* van Beyma, and still less to *Spicaria violacea* Abbott (=*Paecilomyces marquandii* (Massee) Hughes)."

Penicillium albocinerascens Chalabuda (not (Maubl.) Biourge), Not. Syst. Crypt. Inst. Bot. Acad. Sci., U.S.S.R. 6: 166. 1950.

"Colonies on Czapek's agar tomentose, white, becoming gray; reverse white at first then orange. Colonies on sugar beet root extract agar tomentose, at first creamy white, then ashen, at length ash-brown; reverse pale brown; conidiophores 70–80×2–2.5–3μ, ends divaricately branched; sterigmata 6×2–3.5μ; conidia more or less globose, 1.8–2.3μ smooth."

(Translated from Latin diagnosis.)

**Penicillium albo-simplex* Nehira, Jour. Ferm. Tech. Japan 11: 854. 1933.

"On Czapek's agar this fungus grows slowly and is quite floccose; the conidiophores are monoverticillate. The colony does not take on color with age, at 20–25° C. after 30 days the culture takes on a faint color, in part green, also sometimes in part red-violet. The reverse is occasionally purple or dark purple in part. The exudate is colorless or yellow but in old cultures it may be purple. The conidiophores are 2μ wide, monoverticillata-stricta, but sometimes they are branched; the length of the sterigmata is 12μ, the conidia are round, 1.5–2.5μ in dm. and smooth.

"On malt agar it grows with a thick, white edge, sometimes 5 mm wide; when old the fungus becomes partly red-purple. It doesn't grow at 33° C.

"This fungus cannot be found in the literature; its significant characters are as follows:

1. Although it is monoverticillate it occasionally branches.
2. It is floccose.
3. The colony is white but faintly green in age.
4. The reverse is dark purple in spots.
5. The sterigmata are circular and 12μ long."

(Translated from the Japanese by N. Wakabayashi.)

Penicillium allahabadense B. S. Mehrotra and Kumar, Canad. Jour. Bot. 40: 1399. 1962.

"Colonies on Czapek's solution agar growing rather restrictedly, attaining a diameter of 2 to 2.5 cm in 10 days; colonies lanose, granular in appearance and heavily sporulating between celandine and artemisia green (Ridgway, Pl. XLVII), loose, margin white, 1–2 mm wide, exudate lacking; odor not pronounced; reverse pale vinaceous fawn (Ridgway, Pl. XL), conidiophores from the interlacing hyphae, 20–150μ in length by 2.1–2–8μ in width, (3.5μ wide at the swollen tips of monoverticillate type of branches); penicilli strongly asymmetrical divaricate, ramigenous and irregular; metulae 9.5–14.2μ by 2.1–2.5μ, varying in number; sterigmata with fairly well-defined conidium bearing tube, 7.2–9.8μ by 2.0–3.0μ; conidia globose to oval, 2.5–2.8μ in diameter when globose and 2.8–3.3μ when oval, in loose columns.

"Colonies on corn steep agar grow more rapidly and are more deep, otherwise the same as on Czapek. Colonies on malt extract agar plain but rest of the characters same as in Czapek's agar.

"This isolate belongs to the Asymmetrica-Divaricata group as delimited by Raper and Thom (1949) because the penicilli in it are typically divaricate asymmetrical. The presence of green colonies and loose columns of conidia places it in the *P. canescens* series. Out of the three species included in this series, the present isolate comes close only to *P. jenseni*. But even with this latter species it can be distinguished on the basis of the remarkable size differences."

**Penicillium amagasakiense* Kusai, Ann. Rept. Sci. Works, Fac. Sci. Osaka Univ. 8: 43. 1960.

"Colonies of *P. amagasakiense* on Czapek's agar, steep agar, and Sakaguchi and Wang agar grow rapidly at 25° C. (Average colony diameter after 12 days was 52 mm on Czapek's agar, 70 mm on steep agar, and 60 mm on Sakaguchi and Wang agar). This fungus grows more rapidly than *P. notatum* and *P. chrysogenum* and furthermore it can grow in a medium with nitrite as the sole nitrogen source. (It is a producer of notatin, also called glucose oxidase.)

"Colonies grown on agar have a velvety texture and are white. The surface of the colony is smooth and the underside is cherry-yellow. The colony exudes a cherry yellow substance into its culture medium during cultivation.

"It is difficult to induce conidia formation by *P. amagasakiense* on the above 3 agars. To observe the production of conidia, potato agar was used. The penicillus was then typically biverticillate and asymmetric. Conidiophores of 80–200μ×3–4.5μ arose from the substratum. Branching was absent. Metulae were located usually in groups of 4 to 8 and were of 9–15μ×2.5–4.0μ, and the apices had the same shapes.

"To classify this strain, some microbial properties of *P. amagasakiense* were observed. The results indicated that the growth of this strain is very rapid on Czapek or steep agars and it can assimilate nitrite. The above properties, the texture and color of the surface and the reverse side of the colonies, and their exudations were fairly similar to those of *Penicillium lilacinum* Thom. There are some differences between the two Penicillia; *P. amagasakiense* rarely forms conidia and *P. lilacinum* cannot produce glucose oxidase."

Penicillium arenicola Chalabuda, Not. Syst. Crypt. Inst. Bot. Acad. Sci., U.S.S.R. 6: 162. 1950.

"Colonies on Czapek's agar strongly limited in growth, full of mounds, hard, rosy, rarely feathery covered, afterwards brown, reverse brown with rosy agar. Colonies on sugar beet root extract agar irregular, hard base, full of mounds, dark brown, rarely gray-covered, zonate and no margin. Mycelium sooty, more or less brown, hyaline, often distinguished by numerous septa; hyphae often inflated. Reverse dark brown, later dark. Conidiophores septate, 12–100×2.5–3.5μ, ends inflated, 4–5μ. Penicilli asymmetric, in two rows, more or less compact: metulae 10–14×3.5–4μ; sterigmata 7.6–11.6×3–4.5μ. Conidia lemon-shaped, then ellipsoid-globose, almost slightly roughened, 3.7–4.5×3.5–4μ, yellow or pale brown in mass."
(Translated from Latin diagnosis.)

**Penicillium aromaticum* Sopp forma *microsporum* Romankova, Sci. Papers Lenin Univ. 191 (Biol. Ser. 40), p. 102. 1955.

"Colonies on Czapek's agar are velvety, yellow-green, the same color as on wort agar. Conidiophores are rough, conidia are smooth, round,

measuring 2.8–3.0μ. The penicillus is asymmetrical, compact. Gelatin is degraded in 5 days of growth. An aromatic odor in the culture is detected on wort agar and on Czapek's medium but sometimes the odor is not expressed. It distinguishes itself from *Penicillium aromaticum* (Sopp) by the size of the conidia (dimensions of conidia of species described by Sopp are 4–7μ)."
(Translated from the Russian by J. O. Legg.)

NOTE: The "Index of Fungi" questions this as being the first publication for this forma.

Penicillium aspergilliforme Kulik, Not. Syst. Sect. Crypt. Inst. Bot. Acad. Sci., U.S.S.R. 13: 135. 1960.

"On acid potato agar and on Czapek's agar colonies develop slowly, olivaceous, dark-olivaceous, velvety, margin hyaline growing broadly, reverse dark-olivaceous, black in older cultures.

"Conidiophores shrub-like arising from hyphal substrate, simple, erect, smooth, thick *tinica*, olivaceous, dark, septate, 3–5 septa plainly marked, 90–200×3.2–4.8μ, broad walled foot cell similar to that of an *Aspergillus*, not at all rarely globose or obclavate. Penicilli triverticillate, 24.5–31.5μ, typically symmetrical, sometimes asymmetric. Branches olivaceous, 8.1–13.3×2.5–3.4–(4.4)μ. Metulae cylindrical, pale olivaceous, 6.3–8.6×2.2–2.9–(3.7)μ. Sterigmata hyaline, tapering gradually to the apices, 11.6–12.6×2.1–3μ. Conidia olivaceous in mass, elliptical to cylindrical, 3.6–4.7×2.2–3.0μ, at first in short chains (4–6) later in small globose heads 25–45μ in dm. stuck together by mucilage."
(Translated from Latin diagnosis.)

NOTE: "*Penicillium aspergilliforme* Kulik, 1960, is a later homonym of *P. aspergilliforme* Bainier, 1907." Index of Fungi, vol. 3, part 3, p. 86.

**Penicillium aspergilloides* Rudakov, Jour. Bot., U.S.S.R. 44: 867. 1959.

"In culture it forms round colonies of 2–3 mm in height. Color of the mycelium is white. The growing zone is in the form of a fringe with radial rays one mm in length.

"On the third to fourth day a pale orange color appears in the center of the colony. This color gradually deepens and spreads to all the mycelium, which at this time grows thickly on the substrate to 4–5 cm.

"In aging colonies the aerial mycelium is lost; it changes into a layer of conidiophores. During further growth of the fungus, its colonies grow duller and duller, the orange tones are lost, the color of the colonies becomes a dirty-crimson. In the center of some colonies appears a short tuft of aerial mycelium of grayish color. On the reverse of the colony, growing in the wort agar medium, is a turbid milk color, slightly yellowish.

"In young colonies the conidiophores are low and not very long.

With growth of the colony, the conidiophores become rough and longer. In old cultures conidiophores are slightly curved, saber-shaped, their length attaining 1.5–2 mm, and 5–6μ wide.

"The color of the mature conidiophore is a light brown with traces of orange tones. The wall is thick and smooth. The penicillus is composed of metulae and sterigmata, or more rarely, of little bundles of sterigmata at the apex of the conidiophore. Unbranched conidiophores are not displayed. The branches are arranged in several rows along each side of the conidiophore or in lines with one or the other sides. Many of the conidiophores have only one-sided branches.

"Branches of the conidiophore usually are together, imitating a '3-pronged' penicillus. Length of branchlets is about 30μ. On their extremities are formed cylindrical metulae in two's, with a length of about 9μ and about 3.8μ thick.

"Sterigmata are bottle-shaped with some swelling in the middle, and are desiccated and slightly drawn out at the top, 7.5×2.3μ. On each metula grow sterigmata by three's. They distribute themselves in such a way that those at the top bristle out one from another, but those of the side and base are closely squeezed together, in connection with which they can be poorly examined in old conidiophores.

"Conidia of the fungus are ellipsoidal, colorless, with fine, not prominent walls measuring 1.9–2.4×2.2–2.8μ. The conidia form long chains, projecting out on all sides, not sticking together with slime. The upper part of the chain easily becomes detached and this is seen in water mounts where it disperses into individual spores. The lower part does not become detached or become dispersed in water."
(Translated from the Russian by J. O. Legg.)

Penicillium asperosporum G. Smith, Trans. Brit. Mycol. Soc. 48: 275. 1965. (*P. echinosporum* G. Smith, Trans. Brit. Mycol. Soc. 45: 387. 1962.)[5]

"Colonies on Czapek agar growing very slowly, 5–6 mm. diam. in 2 weeks, dark grey with scarcely any suggestion of green, close velvety, radiate to fimbriate, sporing freely, with reverse uncoloured; on malt agar growing somewhat more rapidly, thick velvety, very yellowish green at first, darkening and becoming greyer, with white margin about 1 mm. broad; on potato and carrot agars growing moderately well, thick velvety, dark yellowish green, eventually turning almost pure grey, with very narrow bluish zone and exceedingly narrow white edge, reverse uncoloured.

"Penicilli consisting of a cluster of 2–4 metulae, each bearing phialides, thus biverticillate, but not typical of the section Biverticillata-Symmetrica; conidiophores arising from the substrate, fairly long, smooth, 2–2.8μ diam.; metulae 9–10×3μ; phialides with swollen base, then tapering abruptly to a long slender tip, 8(10)μ long and 3μ diam. at base; conidia globose, very spiny, 4.5–5μ diam., usually separated

[5] The name of this fungus was changed from *P. echinosporum* to *P. asperosporum* because the former epithet had already been used by Nehira (1933) for another taxon. The description is taken from the 1962 paper by G. Smith.

in the chains by conspicuous connectives, mostly 1.5–2μ long but occasionally up to 3μ."

**Penicillium asperum* (Cheer) Sizova and Suprun, Bul. Soc. Nat. Moscow, Biol. 67: 114. 1962.

This fungus is *P. asperum* (Shear) Raper and Thom.

Penicillium atrovenetum G. Smith, Trans. Brit. Myclo. Soc. 39:112. 1956.

"Colonies on Czapek agar growing somewhat restrictedly, thick velvety, bright bluish green (venetus) at first, rapidly turning greyer and becoming deep greyish blue, almost black in age, with narrow white edge during the growing period; respiration drops numerous, faint yellow, drying up and leaving the surface apparently pitted; reverse deep yellowish brown, diffusing very slightly. Colonies on potato dextrose agar very similar; on malt agar somewhat similar but with more rapid and spreading growth. Penicilli biverticillate (but not with the appearance of the Biverticillata-Symmetrica) or asymmetric, with a terminal cluster of metulae, often of unequal length, and usually one branch from a lower node, bearing metulae and phialides or phialides alone; conidiophores mostly long, up to about 300μ, arising from the substrate or from a basal felt of hyphae, smooth or slightly rough, 2.5–4μ diam.; metulae 11–12$\times$3–4μ, often widening somewhat towards the apex; phialides abruptly pointed (not acuminate), 8–10$\times$2–2.8μ; conidia globose, conspicuously rough, exceptionally 2.7μ but mostly 3–3.6μ diam.; conidial chains long, in several loose columns, one to each metula, but sometimes becoming tangled.

"This species is closely related to *P. herquei* Bainier, both morphologically and biochemically. (However, Smith believes that *P. herquei* is wrongly placed in the Biverticillata-Symmetrica. He would put both *P. atrovenetum* and *P. herquei* in the *P. chrysogenum* series, and he would place this series in the Asymmetrica-Velutina.)"

Penicillium atrovirens G. Smith (Syn. *P. decumbens* Thom var. *atrovirens* Abe), Trans. Brit. Mycol. Soc. 46: 344. 1963.

"Colonies on Czapek agar growing slowly, dark bluish grey-green, with fairly broad white edge during the growing periods, velvety but usually heaped in the centre; reverse uncoloured; penicilli mostly monoverticillate but with an occasional branched conidiophore, and very occasionally forming small verticils of 2–3 metulae; conidiophores long, slightly rough, 2μ diam; phialides 10–12$\times$2.0–2.5μ; conidia ovid, rough, 2.8–3.2$\times$2.2–2.4μ; in parallel to somewhat divergent chains.

"This species is markedly different from *P. decumbens* and does not fit any of the known species in the Monoverticillata."

Penicillium aurantiacum J. H. Miller, Giddens, and Foster, Mycologia 49: 797. 1957.

"Colonies on Czapek's agar orange-pink to salmon orange (Ridgway Pl. 2) floccose-funiculose, 4–5 mm in diam. at 10 days at 25° C.; reverse at first orange then brownish-black, not zoned, sporing areas light grayish green, sparse, chiefly in center of colony; conidiophores from ropes of aerial hyphae or when several colonies are in plate, developing from substrate hyphae between colonies, rough, reclining or erect, 30–80×3μ; penicilli distinctly asymmetrical, 50–80μ long, 1–2 branches and metulae oriented at different levels on the conidiophore, faintly echinulate, 8–12×2.5–3μ; with sterigmata smooth, with attenuate apices, closely appressed, 10–14×2–2.5μ. Sporulation is best on corn meal agar and very sparse on Czapek's or malt agar. Conidial chains tangled in age. Conidia elliptical, glabrous, hyaline, 3–4×2–2.6μ.

"This (species) differs from *P. pallidum* G. Smith in colony color and in having only the conidiophores roughened to any extent."

Penicillium bilaji Chalabuda, Not. Syst. Crypt. Inst. Bot. Acad. Sci., U.S.S.R. 6: 165. 1950.

"Colonies on Czapek's agar growing very slowly, somewhat pubescent, uncolored for some time then ash-green, reverse uncolored, then golden with the agar of like color. Colonies on sugar beet root extract agar sometimes hardly moundlike, initially yellow-white, quickly dark-green olivaceous, somewhat pubescent; reverse golden dark-brown with the agar of like color, conidiophores 3μ wide, over 100μ long, simple, tips with 9–14 sterigmata, 12–19×2.5–3μ. Conidia globose, 2–2.75–(3)μ, smooth."

(Translated from Latin diagnosis.)

Penicillium botryosum Batista and Maia, Ann. Soc. Biol. Pernambuco 15: 157. 1957.

"Colonies on neutral Czapek's agar are characterized by appearing depressed in the central area and flat-undulating at the periphery, distinctly zonate and appearing floccose, 1–2 mm wide, of apparently felt-like base and loose aerial mycelium, of delicate hyphae, ash-green, white inter-twined, attaining at 10–12 days, at an ambient temperature of 24–26° C., 4–5 cm. dm; superficially radially furrowed, however, in the young colonies such furrows do not extend to the margins, which are preserved as small, white borders of 0.5–0.8 mm. in dm; exudate slight, yellow, or absent; strong odor, reminiscent of moldy substances; reverse intense yellow or brick-red.

"Conidiophores arising from submerged hyphae or from aerial hyphae, walls smooth or slightly roughened, septate, hyaline or yellow-greenish, 67.5–137.5×2.5–3.5μ, exhibiting typically monoverticillate branches on inflated vesicles similar to *Aspergillus sydowi* Bain. and Sart., but the two types of penicillus, biverticillate and polyverticillate, are more abundant.

"The vesicular branches, with very inflated tips or not, number 2–3 per conidiophore, reaching 11–13.5×4.5–5.5μ.

"The normal branches, two per conidiophore, and of 20–25×2.5–3.5μ, bear verticils of 3–5 club-shaped, divergent metulae, that measure 10–17.5×2.5–3.5μ. The sterigmata are flask-shaped, 4–10 or more, grouped in clusters, 3.5–4.5×1–2μ, with short, conidial tubes.

"Globose conidia, thick-walled, smooth, yellow, 2.2μ dm., separated or forming short chains.

"Cleistothecia and sclerotia absent.

"The species in question although closely related to *Penicillium restrictum*, Gilman and Abbott, is distinguished from it, in (the authors') opinion, by the difference in its colony appearance on Czapek's agar as well as the different characteristics of its conidiophores."
(Translated from the Portuguese.)

Penicillium brasilianum Batista apud Batista and Maia, Ann. Soc. Biol. Pernambuco 15: 160. 1957.

"The colonies on neutral Czapek's agar, after 10 days and at ambient temperature, appear thin, 3.5–4 cm. dm., gray-green velvety, superficially floccose, curled, flat, sometimes umbonate, with radial depressions, defined borders, 2–10 mm dm; when young, up to 3 days old, they are white; azonate; no odor and without exudate; reverse yellow, in some strains appearing orange-yellow and immediately dark maroon.

"Vegetative mycelium submerged, hyaline. Conidiophores originating from the mycelium, erect, slightly rough, septate, walls thin and yellow, abundant throughout the colony and reaching up to 480μ in length and 2–2.8μ in dm.

"Terminal penicillus somewhat divaricate or on strongly divaricate branches. Branches 8–20×2–3μ. Metulae truncate, incurved, in verticils of 2–6, attaining 7.5–12×2.5–3μ.

"Some strains do not possess branches and the verticils of metulae can be compared to monoverticillate structures. Sterigmata 5–8 per metula, approximately of the same length, appearing fusoid with the ends finely tubuliform 5.5–10×2.5μ.

"Conidia in short or long chains, not becoming however more than 200μ long; they are subglobose or elliptical, of yellow-green shade, echinulate, however with a thin wall, 3.6×4.5–5μ.

"Perithecia and sclerotia absent."
(Translated from the Portuguese.)

**Penicillium brunneostoloniferum* Abe (as "*brunneo-stoloniferum*"), Jour. Gen. Appl. Microbiol., Tokyo 2: 104. 1956.

"Colonies on Czapek agar grow rather rapidly, attaining a diameter of approximately 46 mm. in 10 to 12 days at 25° C.; strongly wrinkled and buckled, with central area somewhat raised, consisting of a close-textured mycelial felt bearing abundant conidial structures, with sur-

face typically velvety, with a white margin 1.0 mm. wide, and colony circumference slightly rugged; conidial structures abundantly produced throughout the whole colony, typically in light brown shades near Buckthorn Brown or Clay, becoming Verona Brown in marginal areas and Sayal Brown in central areas with age; exudate lacking; odor limited, moldy; reverse in yellow or light brown shades near Antimony Yellow or Cinnamon, becoming Sayal Brown in central areas and Yellow Ocher in marginal areas; surrounding agar strongly diffused in yellow shades; conidiophores arising from the substratum or basel felt, ranging up to 120–220μ in length by 4.1–5.0μ in diameter, with apices 4.4–6.2μ in diameter, and small punctate walls; penicilli typically biverticillate and asymmetrical, short and compact, commonly one or more branches in addition to the main axis, terminating in verticils of 3 to 6 metulae-bearing sterigmata; branches usually short, 17.5–18.7μ in length by 3.1–4.3μ in diameter, usually 9.3–12.5μ by 3.1–3.7μ; sterigmata in fairly compact verticils of 4 to 7, mostly 9.3–11.2μ by 2.1–2.6μ, acute type; conidia elliptical to subglobose, mostly 2.3–3.3μ by 2.1–2.8μ, echinulate or verruculose walls; conidial chains loosely parallel to divergent, up to 60 to 170μ in length; and conidia showing echinulate or verruculose walls in electron microscopy.

"Colonies on steep agar grow rapidly, about 44 mm. in 10 to 12 days at 25° C.; the other characters are as described above.

"This strain differs from *P. stoloniferum* Thom primarily in the bright brown shades of its conidial areas, in the rather rapidly spreading character of its growth, the typically elliptical to subglobose form of its conidia, the rough walls of its conidiophores, and also in the non-production of a stolen margin."

NOTE: "*P. brunneostoloniferum* Abe is *P. ochraceum Bainier*." G. Smith, Trans. Brit. Mycol. Soc. 46: 332. 1963.

Penicillium brunneum Udagawa, Jour. Agr. Sci. Tokyo Nogyo Daigaku 5: 16. 1959.

"Colonies on Czapek agar rather rapidly growing, strictly tufty with tendency to become fasciculate, but not developing definite coremia, thick with a tough basal felt up to 3 mm. deep, conspicuously wrinkled, conidial areas at first vinaceous-fawn to avellaneous (Ridgeway, 1912), then Dresden brown in age, often with a yellowish cast from intermixed vegetative mycelium, with fimbriate margins yellowish, abrupt, exudate abundant, slimy, reverse yellow orange. Conidiophores usually arising from the basal mycelium, but also from aerial hyphae, 50–200×3–3.2μ, with walls smooth or often verrucose with yellow granules, septate. Penicilli typically biverticillate and symmetrical. Metulae 4–8 (10) in number, 9.5–12×2.5–3.2μ. Sterigmata lanceolate with narrowed apices, 10.5–13(14.5)×2.5–3μ, in verticils of 5–8. Conidia ellipsoid to subglobose, 3.2–3.5×3–3.2μ, sometimes with pointed ends, smooth-walled, borne in tangled chains to 40–70μ in length.

"On malt agar, rather restricted, in texture and appearance basically as on Czapek but fairly fasciculate, more or less zonate, exudate limited, not slimy.

"At 37° C., growth is nil."

**Penicillium camerunense* Heim, Nouvel, and Saccas, Bul. Acad. Belg. Clinical Sci. Ser. 5, 35: 42. 1949.

"The conidia of *P. camerunense* are clearly globose, attaining (2–)3 (–4) × (2–)2.4(–3.5) μ with a maximum deviation of only 2–4μ. The conidiophores of *P. camerunense* are considerably more branched than those of *P. notatum* and the branches of the penicillus are smaller. The secondary branches measure 20–25 × 10–12μ, the tertiary branches 10–12 × 5–7μ and they bear 3 to 4 sterigmata, measuring 8–10 × 5–7μ.

"Growth consists of a thin layer on Sabouraud's agar medium at 25° C. at the end of 60 hours, the colony from an original single spore exceeds 1 cm. in dm., it is blue-green over nearly all of its surface, surrounding an uncolored narrow zone; sporulation is premature, attaining its maximum in about 96 hours. At that time the colony is 2 cm. in dm. and is already deep green-blue. Towards the fifteenth day, the colony changes in color tending toward gray-red.

"At low temperatures or at the beginning of growth under very favorable warm conditions, the fungus culture appears blue, but there is a tendency to green more and more gradually when the temperature is higher. Exudate begins to be produced at 25° C.; at 30° C., the drops are at that time of the same color, larger, and more numerous: We are here in the neighborhood of the optimum temperature that corresponds to 29.5° C. At 33° C., the droplets are reduced in volume and in number, and they present a nearly yellow color."
(Translated from the French.)

NOTE: According to Abe, "cultures received from Kominami & Tubaki as *P. camerunense* Heim duplicated almost exactly the descriptions (ie. Abe's) of *P. chrysogenum*." Jour. Gen. Appl. Microbiol., Tokyo 2: 91. 1956.

Penicillium canadense G. Smith, Trans. Brit. Mycol. Soc. 39: 113. 1956.

"Colonies on Czapek agar plates spreading, thin, at first very pale straw colour, then darkening somewhat to pale fawn with a slight greenish cast, indistinctly zoned, with fimbriate margin; drops not seen; reverse uncoloured. Colonies on Czapek agar slopes at first white and somewhat wet in appearance, then thin matted funiculose, gradually dull greenish fawn, with some white to yellowish overgrowth. Colonies on malt agar growing rapidly, somewhat floccose, white then straw-coloured but with a greenish tone, becoming slightly darker in age and with a fair amount of white aerial mycelium. Penicilli short, very compact, usually with four stages of branching, with the elements successively smaller in diameter as in *Gliocladium;* conidiophores up

to 600μ long, stiff, with granular contents, mostly 5–5.6μ diam., but occasionally more slender and then bearing small penicilli; rami 8–12μ×4–5μ; ramuli 8–10×3.5–4μ; metulae 6.5–7×2.7–3μ, but occasionally up to 10μ long; phialides crowded, abruptly pointed, 6–7 (8) × 2–2.5μ; conidia globose to subglobose, smoothwalled, 3–4×3–3.5μ; conidial chains comparatively short, intricately tangled.

"This species is closely allied to *P. albicans* Bainier, which is, up to the present, the only well-defined species in the group Polyverticillata. The two species are similar in colony color and in the structure of the penicillus. *P. canadense* differs from *P. albicans* in its shorter phialides, globose instead of almost cylindrical conidia, and long and stiff instead of very short conidiophores."

**Penicillium casei* Staub var. *compactum* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 101. 1956.

"Colonies on Czapek agar are rather restrictedly spreading, attaining a diameter of about 34 mm. in 10 to 12 days at 25° C. consisting of a comparatively hard basal felt bearing crowded conidial structures, with a white narrow margin, about 0.3 mm. wide, typically radially furrowed; conidial areas in yellow green shades near Dark Yellowish Green, becoming Andover Green with age; exudate abundant, in yellow or pinkish shades; odor lacking or limited, moldy; conidiophores arising from the substratum or from the basal felt, variable in length, commonly up to 60–300μ by 4.4–6.2μ in diameter, with walls showing large granules or protuberances; penicilli biverticillate and asymmetrical and comparatively compact, commonly showing one or more branches in addition to the main axis, terminating in verticils of 2 to 3 metulae-bearing sterigmata; branches variable, commonly 9.3–15.6μ by 4.4–6.0μ; metulae usually 6.2–11.2μ by 2.5–4.3μ, with apices 3.7–5.0μ in diameter, with granular walls; sterigmata in fairly compact verticils of 3 to 6, mostly 8.7–10.6μ by 2.5–3.2μ, acute type with smooth or slightly punctate walls; conidia ovate to subglobose, mostly 3.1–4.3 by 3.0–3.8μ, spinulose walls; conidial chains usually columnar or loosely columnar, up to 60–150μ in length; and conidia with typical spinulose walls, as seen by electron microscopy. Colonies on steep agar are similar to those described above."

NOTE: Abe also states that the colony reverse is of a milky color (p. 101, loc. cit.).

"This strain differs markedly from *P. casei* Staub primarily in the spinulose walls of its conidia, in the milky color in the reverse, in the *brevi-compactum*-like structure of its penicilli, and in seldom growing at 37° C.

"It also differs markedly from *P. brevi-compactum* Dierckx, primarily in the typical conspicuously rough walls of its conidiophores and branches."

**Penicillium charlesii* G. Smith var. *rapidum* Abe, Jour. Gen. Appl. Microbiol., Tokyo, 2: 73. 1956.

"Colonies on Czapek agar grow rather rapidly, attaining a diameter of 39 to 52 mm. in 10 to 12 days at 25° C.; radiately furrowed, some strains buckled and raised in the central area; appearing velvety or nearly so; sporulating abundantly in dark yellow green shades near Dark American Green or Dark Yellowish Green, becoming Dark Dull Yellow Green or Dusky Olive Green with age, with a white margin, 0.3 to 1.0 mm. wide; exudate lacking; odor limited, moldly; reverse in dull greenish or purple vinaceous shades with surrounding agar colorless; conidiophores arising from creeping or closely interwoven aerial hyphae, simple or variously branched, variable in length, 30–120μ by 2.0–3.1μ in diameter, with apices 2.6–3.7μ in diameter, and with walls smooth or nearly so; penicilli monoverticillate, ramigenous; sterigmata in verticils of 5 to 10, compact or somewhat divergent, mostly 7.9–11.2 or rarely to 12.5μ by 1.5–3.1μ, acute type with smooth walls or nearly so; conidia globose to subglobose, mostly 1.9–3.4 or 3.7μ, with smooth walls or nearly so; chains of conidia in compact or loose columns up to 30–90μ in length; its conidia showing loosely rough walls in electron microscopy.

"Colonies on steep agar grow rather rapidly, 44 to 48 mm. in 10 to 12 days at 25° C., the other characters are as described above.

"These strains are suggestive of *P. charlesii* Smith in the production of monoverticillate and ramigenous penicilli, in the columnar form of their chains of conidia, and in the globose or subglobose character of their conidia. However, they differ markedly from this species in the rather rapidly spreading character of their colonies, their dark yellowish-green color, the purplish vinaceous color of their reverse (only in FAT 806), and the longer sterigmata up to 7.9–11.2 or 12.5μ.

NOTE: "*P. charlesii* G. Smith var. *rapidum* Abe; the reason for the erection of the variety, because of the rather more rapid growth than that of the type, is too trivial to be taken seriously." G. Smith, Trans. Brit. Mycol. Soc. 46: 332. 1963.

**Penicillium chrysogenum* Thom mutant *fulvescens* Takashima, Arima, and Abe, apud Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 92. 1956.

"Colonies of the mutant grown on Czapek and steep agar differ from the original species in the entire absence of green color. This strain was obtained by Takashima and Arima as a mutant from a normal green strain of *P. chrysogenum* Thom (FAT 514) by ultra-violet radiation. Therefore, we recognize the strain as a new variety to which the name *P. chrysogenum* Thom mut. *fulvescens* Takashima, Arima and Abe is assigned because of the cinnamon color of its colonies."

NOTE: "The fungus described as *P. chrysogenum* mut. *fulvescens Abe* should be referred to *P. notatum* Westl. rather than to *P. chrysogenum.*" G. Smith, Trans. Brit. Mycol. Soc. 46: 332. 1963.

Penicillium cinereoatrum Chalabuda, Not. Syst. Crypt. Inst. Bot. Acad. Sci., U.S.S.R. 6: 167. 1950.

"Colonies on Czapek's agar growing very slowly, mouse colored, somewhat tomentose; exudate uncolored, reverse white-rosy, colonies on sugar beet root extract agar tomentose, reddish-brown-ashen, later dark-ashen, growing moderately; yellow-rose exudate, reverse pale yellow brown, with the agar similarly colored, conidiophores simple, 20–40×3.8μ, tips with 37 sterigmata in dense clusters, 5–10×2–2.5μ; conidia initially ellipsoid 2.5–3×2–2.5μ, later globose, 2.5–3.5–(4)μ dm., slightly roughened, olivaceous in mass."
(Translated from Latin.)

Penicillium cinnamopurpureum Abe ex Udagawa, Jour. Agr. Sci. Tokyo Nogyo Daigaku 5: 1. 1959.

"Colonies on malt agar growing rather restrictedly, plane, with conidial sectors velvety and grayish green, reverse dull red near perilla purple (Ridgway, 1912); sclerotia abundantly produced, pink (cinnamon) in shades, spherical to oblong, mostly 150–311μ, hard. Conidiophores arise from aerial hyphae or directly from the substratum, 60–120 or more ×2–3.2μ, with enlarged tip, 4–5μ in diam., walls smooth. Penicilli monoverticillate. Sterigmata in 8–10 verticils, 8–10.5×2–2.5μ, terminating rather abruptly with collarettes. Conidia subglobose to ellipsoid, 1.5–3.2μ, smooth-walled, in chains loosely columnar, 80–150μ.
"At 37° C., growth is poor."

NOTE: Abe gave the following description of this fungus in the Jour. Gen. Appl. Microbiol., Tokyo 2: 52. 1956.

"Colonies on Czapek agar are rather restricted, attaining a diameter of about 16 to 20 mm. in 10 to 12 days at 25° C., buckled and slightly radially wrinkled; typically velvety, with a white narrow margin 0.5 mm. wide; more or less floccose from the development of abundant light vinaceous or brownish vegetal mycelium; conidial structures limited or abundant, marginal or localized, in bluish green shades near Bluish Glaucous; sclerotia in Pinkish Cinnamon becoming Wood Brown or Fawn, elliptical to subglobose; usually characterized by entire colonies composed of thick-walled sclerenchyma-like polygonal cells, hard, crushing with difficulty, mostly 10–18μ in diameter; exudate abundant, in yellow or pinkish shades; odor limited, moldy; reverse in purplish shades in the marginal area, and near Dull Indian Purple becoming Dull Violet Black or Taupe Brown in the central area; penicilli strictly monoverticillate; conidiophores arising from the substratum or from aerial hyphae, seldom branched, smooth walled, 40–120 or 180μ by 2.0–3.1μ, with apices up to 3.1–5.0μ in diameter;

sterigmata in verticils of 5 to 8, parallel, mostly 10.6–12.6 or 15.6μ by 2.0–3.0μ, with conidium bearing tips somewhat narrowed; conidia elliptical to subglobose, 2.1–2.9μ by 1.7–2.1μ, with walls smooth or nearly so; chains of conidia in columns up to 60–200μ in length; and conidia showing smooth or nearly so walls in electron microscopy.

"Colonies on steep agar are rather restricted, 25 to 26 mm. in 10 to 12 days at 25° C., and radially wrinkled; conidial area in pale yellow green shades near Sage Green, strongly purple shades in reverse; the other characters are as described above.

"This strain is suggestive of *P. sclerotiorum* van Beyma, *P. thomii* Maire, and *P. lapidosum* Raper and Fennell, in its production of sclerotia with hard, sclerenchyma-like cells that crush with difficulty.

"However, it differs markedly from *P. sclerotiorum* van Beyma in its infrequent development of bright orange-red mycelium, from *P. thomii* Maire in the abundant production of bright grayish, vinaceous or brownish mycelium, in the smooth or nearly so walls of its conidiophores, and also the dark purplish color in reverse, and from *P. lapidosum* Raper and Fennell in the restricted character of its growth, in the elliptical form of its sclerotia, and also in the purplish color of its reverse. In addition, strains differ markedly from *P. pusillum* Smith in the luxuriant production of sclerotia on Czapek agar, and in the elliptical form of their conidia."

NOTE: D. B. Scott and Amelia C. Stolk reported in "Antonie van Leeuwenhoek" 33: 308, 1967, that this taxon has a perfect stage, which they named *Eupenicillium cinnamopurpureum*. Their description of this stage is given as follows:

"Cleistothecia are spherical to subspherical or ovoid, usually 150–250μ in diameter, in pinkish cinnamon shades becoming brown in age. At first a branched system of aerial hyphae develops into masses of parenchyma-like cells, soon becoming thick-walled and sclerotioid. In the centre of the cleistothecia an extensive network of somewhat irregularly shaped hyphae develops. Locally these hyphae form coiled branched ascogenous hyphae producing clusters of asci. The cleistothecia ripen slowly from the centre outwards. After 6 to 8 weeks ascospores fill the entire cleistothecium except for a thin outer wall or peridium consisting of a single layer of cells. Asci are borne singly as branches from ascogenous hyphae, very rarely two or three asci occur in a short chain. Asci are spherical to subspherical, mostly 7–8μ in diameter, and contain 8 spores. Ascospores are lenticular in shape and measure 3.0–3.5μ by 2.5–2.8μ. They are slightly yellow when matured and show two small, equatorial ridges with convex surfaces very finely roughened."

**Penicillium citreovirens* Abe (as "*citreo-virens*"), Jour. Gen. Appl. Microbiol., Tokyo 2: 87. 1956.

"Colonies on Czapek agar grow rather rapidly, attaining a diameter of 47 to 49 mm. in 10 to 12 days at 25° C., consisting of a somewhat compact basal felt, appearing typically velvety, with a white margin about 1.0 mm. wide, smooth, sporulating abundantly in bright yellow

green shades near Empire Green, becoming Cress Green with age; exudate lacking; odor limited or indefinite, moldy; reverse usually in cream shades; becoming typically green-olive in the central area and sepia in the marginal areas; surrounding agar usually colorless; conidiophores arising mostly from the substratum or from basal felt, mostly 60–250μ in length by 2.5–2.7μ in diameter, with apices 2.8–4.7μ in diameter and with walls smooth or nearly so, usually unbranched; penicilli typically biverticillate and asymmetrical, consisting of a terminal group of 3 to 5 compact or slightly divergent metulae that measure about 12.5–25.0μ by 2.5–3.7μ (apices commonly enlarged to 2.6–4.7μ), each supporting a cluster of 3 to 7 compact or parallel sterigmata measuring about 7.5–11.9μ by 1.7–2.5μ and bearing conidia in columns or loosely tangled chains up to 60–120μ in length; conidia globose to subglobose, mostly 2.3–3.3μ, smooth-walled or nearly so; and conidia walls delicately roughened (spines less than 0.1μ) as shown in electron microscopy.

"Colonies on steep agar grow rather rapidly, up to 42 to 47 mm. in 10 to 12 days at 25° C., colonies are loosely radially furrowed, and reverse is in typical olive green shades; the other characters are as described above.

"Colonies on Koji-extract agar are similar to steep and Czapek agar, but typical in dusky olive green shades in reverse that characterized it.

"These strains differ markedly from *P. citrinum* Thom in the longer (12.5–25.0μ) metulae, in the typical green color in reverse on Czapek and steep or Koji-extract agar, and also the bright yellow-green colony color. They also differ from *P. steckii* Zaleski primarily in the compact or slightly divergent arrangement of the metulae, in the typical green color in reverse and the size of conidia.

"The correct placement of the species remains in doubt, but it appears to be most satisfactorily assignable to (the *P. citrinum* series) in the Velutina subsection of the Asymmetrica as in the classification of Raper and Thom."

NOTE: "*P. citreovirens* Abe is *P. spinulosum* Thom." G. Smith, Trans. Brit. Mycol. Soc. 46: 332. 1963.

**Penicillium citreoviride* Biourge var. *aeneum* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 58. 1956.

"Colonies on Czapek agar are rather restrictedly spreading, attaining a diameter of 22 to 30 mm. in 10 to 12 days at 25° C, typically velvety or velutinous, with a white narrow margin, 0.3 to 1.0 mm. wide, buckled or sulcate, some strains radiately furrowed, sporulating abundantly in pale yellow green shades near Sage Green or Vetiver Green, becoming Tea Green or Citrine Drab; exudate lacking or limited, pale yellow shades; odor lacking or slight, moldy; reverse in greenish yellow shades near Oil Yellow or Aniline Yellow in marginal area and in brownish shades in central area, localized; conidiophores usually arising from the subtratum or basal felt, mostly 30–120μ long by 1.7–2.3μ diameter, with apices enlarged to 2.4–3.5μ diameter, with apices enlarged to 2.4–3.5μ in diameter and walls smooth or nearly so;

penicilli strictly monoverticillate; sterigmata in verticils of 5 to 12, compact or loose, mostly 6.8–8.7μ by 1.3–2.3μ, acute type; conidia globose to subglobose, 1.5–2.3μ, with smooth or nearly so walls; chains of conidia loosely parallel or in columns, up to 30–90μ in length; its conidia showing delicately rough walls (spines less than 0.1μ) in electron microscopy.

"Colonies on steep agar restrictedly spreading, up to 30 to 35 mm. in 10 to 13 days at 25° C; the other characters as described above.

"These strains are separated from *P. citreo-viride* Biourge, however, by the pale yellow-green color of their colonies, by the usually brownish color in the central area of the reverse, and by the typically velvety colony character."

NOTE: "*P. citreoviride* Biourge var. *aeneum* Abe becomes *P. aeneum* G. Smith." Trans. Brit. Mycol. Soc. 46: 332. 1963.

**Penicillium claviforme* Bainier mutant *candicans* Abe and Ura apud Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 116. 1956.

"Colonies of the variety *candicans* on Czapek and steep agar differ from the species in the entire absence of green color.

"This strain, received in 1952 from Mr. T. Ura, University of Kyoto (No. M 15–5), as *Penicillium* sp. was obtained from a normal green strain of FAT 1263 (described above) by ultra-violet irradiation. Therefore, we consider it as representing a new variety to which the name *P. claviforme* Bainier mut. *candicans* Abe and Ura is assigned because of the white color of its colonies."

**Penicillium claviforme* Bainier mutant *olivicolor* Abe and Ura apud Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 116. 1956.

"Colonies of the variety *olivicolor* on Czapek and steep agar differ from the species in the entire absence of green color.

"The strain received in 1952 from Mr. T. Ura, University of Kyoto, (their No. M 15–9), as a *Penicillium* was obtained from a normal green strain of FAT 1263 (as described above) by ultra-violet irradiation. Therefore, we consider it as representing a new variety to which the name *P. claviforme* Bainier mut. *olivicolor* Abe and Ura is assigned because of the olivish color of its colonies."

Penicillium coeruleoviride G. Smith, Trans. Brit. Mycol. Soc. 48: 274. 1965.

"Colonies on Czapek agar spreading broadly, rich green with a bluish cast, with white margin about 2 mm. broad during the growing period, turning darker and greyish from the centre outwards, velvety, with marked zonation in the outer areas, with reverse uncoloured; drops nil; penicilli compact, with verticils of metulae, but not Bivertic-illate-Symmetrical; conidiophores slightly rough, 3.2–4μ diam.;

metulae smooth, 12–16×3–4μ; phialides 9–12×2–2.5μ; conidia subglobose to definitely ovate, 3–3.2μ in long axis; conidial chains tangled.

"This species belongs in the group Biverticillate-Asymmetrica, ie. the *P. citrinum* series. It is nearest to *P. paraherquei* Abe ex G. Smith, but differs from the latter in its more rapid growth, lack of reverse color, longer and smooth metulae, longer phialides, and somewhat larger conidia."

**Penicillium concavorugulosum* Abe (as "*concavo-rugulosum*"), Jour. Gen. Appl. Microbiol., Tokyo 2: 127. 1956.

"Colonies on Czapek agar grow rather restrictedly, attaining a diameter of 27 to 37 mm. in 10 to 12 days at 25° C., consisting of a comparatively thin basel felt bearing crowded conidial structures, usually typically velvety, sometimes with yellow encrusted vegetative hyphae, a pale yellow margin 0.5 to 1.3 mm. in width, conidial areas in bright yellow green or dark yellow green; exudate lacking or limited and light orange; odor almost lacking or indistinct, moldy; reverse in orange, orange-red or orange-brown, either localized or throughout, with surrounding agar seldom pigmented in about 3 weeks; conidiophores arising primarily from the substratum or basal felt, mostly up to 60–250μ or 320μ in length by 2.5–3.8μ in diameter, with walls smooth or nearly so, apices to 3.1–5.0μ in diameter; penicilli typically biverticillate and symmetrical, usually consisting of single verticils of 4 to 8 loosely compact or somewhat divergent metulae, each terminating in verticils of 4 to 6 sterigmata; metulae mostly 10.6–17.5μ by 2.3–3.5μ; acuminate closely parallel, mostly 11.0–14.0μ by 1.8–2.7μ, conidia typically long elliptical, mostly 3.1–4.3μ by 2.1–3.0μ, with walls smooth or slightly roughened; conidial chains usually loosely parallel or tangled, up to 60–150μ or 180μ in length; and conidia showing delicately roughened walls (less than 0.1μ) in electron microscopy.

"Colonies on steep agar grow rather restrictedly, 30 to 42 mm. in 10 to 12 days at 25° C.; the other characters are as described above.

"These strains differ markedly from *P. rugulosum* Thom primarily in the typically long elliptical conidia (3.1–4.3μ in long axis), seldom showing rugulose walls, in colonies mostly 27 to 37mm. in diameter on Czapek agar and in the somewhat longer (mostly 10.6–17.5μ) metulae.

"They also differ markedly from *P. variabile* Sopp primarily in the colored mycelium compactly admixed with conidial heads, in the lack of prominent areas of sterile yellow aerial mycelium, and in the character of seldom growing at 37° C."

NOTE: "*P. concavorugulosum* Abe is *P. rugulosum* Thom." G. Smith, Trans. Brit. Mycol. Soc. 46: 332. 1963.

Penicillium coralligerum Nicot and Pionnat, Soc. Mycol. de France, Bul. 78(3): 246. 1962.

"On Czapek's medium the colony attains a diameter of about 4 cm. in 2 weeks, the optimum growth is found between 18 and 22° C. It is compact, radially furrowed, slightly depressed in the center and bor-

dered by a regular margin of about 2 mm. of a dirty white, becoming green glaucous when sporulation progresses. The surface is dirty red coral and of a grainy aspect due to the presence of a continuous layer and series of small sclerotia, very weakly masked by the development of a not very thick, fertile mycelium, gray-green, slightly floccose; in the central region the mycelium is in greater abundance, gray-green to slightly bluish, tufted, not very high (1–2 mm.). The droplets of exudate appear hyaline especially in the peripheral region. The odor, which is indistinct, is later fruity and similar to apple. The colony reverse, radially furrowed, is strongly pigmented, green emerald to dark green more or less fluorescent in the center, under the zone of fertile mycelium, brown rose to dark brown at the level of sclerotia; the dirty yellow-green pigment diffuses largely more or less during the growth of the culture.

"On malt extract agar, the conidial phase is more abundant than on Czapek's medium, the fertile mycelium is grayish-green, slightly floccose, entirely covering the rose-coral sclerotia. The culture is more or less zonate, and the development of the sclerotia in a radial direction affects the margin of which the outline is generally indented. The exudate is not very abundant, and the apple odor is clearly marked. The colony reverse, slightly furrowed, is of an intense green turning to green-brown, darker at the edge, with a very clear diffusion zone, of several mm in length, green-yellow fluorescent.

"The arrangement of the penicilli is clearly biverticillate, and recalls that of *P. herquei* Bain and Sart. The generally simple conidiophores, erect over the medium, from 300–350μ long, attain a diameter of 3.5–4.5μ. Of rugged appearance in dry mounts, they are sometimes apparently smooth on liquid media; as with many species of *Penicillium*, the roughness of the walls is more accentuated on malt agar than on Czapek's. Rarely, the conidiophore is provided with a side branch 15–30μ long. The conidiophore, as well as the side branches, bear a regular verticil of 4 to 6 metulae, relatively short and more or less divergent; the latter are frequently rough, slightly enlarged at the ends, from 10–13$\times$3–3.5μ; the sterigmata rather crowded, from 7–9$\times$2–2.5μ, bearing long chains of globose to subglobose conidia, of small size (2–2.5μ), smooth or very finely echinulate.

"The rose-colored sclerotia of firm consistency, stony, globose or of regular form, enveloped by a thin matting of hyphae, are always of small size (120–250$\times$150–350μ). Their structure is analogous to that of the sclerotia of the Penicillia in the series *raistrickii* and *thomii*.

"It is related to *P. herquei* but with sclerotia similar to those exhibited by the *P. raistrickii* series."
(Translated from the French.)

**Penicillin corylophiloides* Abe, Jour. Gen. Appl. Microbial., Tokyo 2:89. 1956.

"Colonies on Czapek agar grow rather restrictedly, attaining a diameter of 2.7 to 3.2 mm. in 10 to 12 days at 25° C, consisting of somewhat compact basal felt, typically velvety, with a white narrow margin 0.2 to 0.3 mm. wide, smooth or slightly furrowed, sporulating abun-

dantly in dull yellow green shade near Dark Greenish Glaucous, American Green or Pistachio Green, becoming Dusky Olive Green or Andover Green with age; exudate abundant, colorless; reverse at first colorless or pale yellow, becoming pale olive, with surrounding agar colorless; penicilli typically biverticillate and asymmetrical, seldom producing branches; conidiophores arising mostly from the substratum, or from basal felt, mostly 130–180μ length by 2.5–3.2μ diameter, with apices enlarged, 3.4–4.7μ in diameter, smooth walled or nearly so usually unbranched; metulae in a terminal verticil of 4 to 5 or occasionally 8, variable in length, mostly 12.5–18.7μ by 2.5–3.4μ, each supporting a group of 5 to 8 sterigmata measuring about 10.0–11.9μ by 2.0–2.8μ, typically acute type and smooth walled or nearly so; conidia elliptical to subglobose mostly 2.5–3.4μ by 2.0–2.6μ, with smooth walls or nearly so; chains of conidia in tangled or loose columns, up to 60–90μ in length; conidia showing delicately rough walls in electron microscopy.

"Colonies on steep agar grow somewhat rapidly, up to 34 to 43 mm. in 10 to 12 days at 25° C; colonies broadly radially furrowed; the other characters are as described above.

"These strains differ markedly from *P. corylophilum* Dierckx, primarily in the colorless or pale-yellow colony reverse, in the 4 to 8 terminal verticils of the metulae, and in their length (12.5–18.7μ).

"They also differ markedly from *P. paxilli* Bainier primarily in the unequal lengths of the rather long metulae, and from *P. steckii* Zaleski and *P. citrinum* Thom primarily in the typically elliptical conidia.

"The correct placement of the species remains in doubt, but it appears to be most satisfactorily assignable to the *P. citrinum* series in the Velutina subsection of the Asymmetrica, as in the classification of Raper and Thom."

NOTE: "*P. corylophiloides* Abe is well within the range exhibited by *P. corylophilum* Dierckx, though it differs in minor details from the more typical isolates of this species; the name should be dropped." G. Smith, Trans. Brit. Mycol. Soc. 46: 332. 1963.

Penicillium cremeogriseum Chalabuda, Not. Syst. Crypt. Inst. Bot. Acad. Sci., U.S.S.R. 6: 168. 1950.

"Colonies on Czapek's agar initially white later pale cream-gray, marginal zone uncolored, reverse white-rose. Colonies on sugar beet root extract agar growing rapidly, at first white, then cream colored, tomentose, marginal zone uncolored; reverse pale yellow at first then vinaceous-brown. Conidiophores 20–40μ long, simple, hardly ever with small branches, upper parts slightly roughened, tip 3–5μ, sterigmata 8–11$\times$2.5μ, arising from creeping, submerged hyphae or hyphal ropes; conidia more or less globose, almost warty, 2–2.75μ dm., formed in small columns."

(Translated from Latin diagnosis.)

Penicillium crocicola Yamamoto apud Yamamoto, Maeda, and Oyasu, Sci. Rpt. Hyogo Univ. Agr., Agr. Biol. Ser. 2(2) : 28. 1956.

"Colonies fairly rapidly growing on Czapek's agar, composed of slender, dense, crowded mycelium, sclerotia produced abundantly, central area more or less raised, radially furrowed, blue-gray, then olivaceous-green or grayish-green, exudate lacking; odor not distinctive, reverse pale orange-red or yellow-orange, pigment hardly dissolving in the medium; conidiophores arising from substrate or aerial mycelium erect, 2–5 septate, smooth, hyaline, 32–106μ high, 3–4μ diam., penicilli monoverticillate; sterigmata 4–20 in each conidiophore, flask-shaped, 7–14μ long, 2.5–3.5μ dm.; conidia arranged in divergent chains, for the most part subglobose, sometimes globose, pale-yellowish-green, smooth, 2.3–3.5μ long, 2–3μ dm; sclerotia in dense clusters, subglobose up to ellipsoid, yellow-brown up to dark brown, 140–320μ long, 130–255μ dm."
(Translated from Latin diagnosis.)

**Penicillium crustosum* Thom var. *spinulosporum* Sasaki, Jour. Fac. Agr. Hokkaido Univ. 49 : 158. 1950.

"Colonies on Czapek's solution-agar spreading, fasciculate or velvety, zonate broadly, with the development of continuous crusts of conidial chains, which break off as irregular masses when struck or tapped; drops colorless; odor slightly fruity; conidial area elm green or varley's green (Rdg., XVII, 27′–XVIII, 31′) when young, olive-brown (Rdg., XL, 17‴) in old cultures; reverse colorless or cream color to naples yellow (Rdg., XVI, 19′), margin gnaphalium green (Rdg., XLVII, 29⁗) ; substratum uncolored. Conidiophores 60–300μ long by 4–5μ in diameter, with walls rough pitted, single or coremiform; penicillus consisting usually of the main axis and one branch variously up to 40μ long appressed with few metulae 10–18μ long and groups of sterigmata 10–11 by 3–4μ; conidia globose 3–4.5μ in diameter, markedly spinulose; conidial chains parallel; sclerotia or perithecia not found.

"Growth on Koji extract-gelatin abundant, andover green (Rdg., XLVII, 25⁗) ; reverse radiately wrinkled, light grayish olive (Rdg., XLVI, 21⁗), margin olive ocher (Rdg., XXX, 21″) ; gelatin liquefied partly, becoming slightly brownish.

"Growth on potato abundant, velvety, Lincoln green (Rdg., XLI, 25‴).

"Milk strongly peptonized; litmus changed to blue at first, then neutral, through faint red, reduced at last."

Penicillium cyclopium West var. *album* G. Smith, Trans. Brit. Mycol. Soc. 34: 18. 1951.

"Cultures have exactly the characters of *P. cyclopium* West. except for the total lack of conidial pigment. Colonies granular velvety, in-

distinctly zoned, persistently white even in age with reverse pale yellowish brown and strong mouldy odour; penicilli typical, asymmetric with normally three stages of branching; conidiophores rough, 3–5μ in diameter; phialides 10–11×2.5μ; conidia globose to subglobose, smooth, 3.1–3.8μ diameter."

Penicillium cylindrosporum G. Smith Trans. Brit. Mycol. Soc. 40: 483. 1957.

"Colonies on Czapek agar thin velvety, inclined to be patchy, dull avellaneous, with reverse uncoloured; on malt agar growing fairly well, velvety, dull avellaneous with sordid yellow margin and with reverse dark dirty greenish brown; on potato agar similar except that the reverse is somewhat more greenish; stated by Mrs. J. Robson (from whom the original culture was received) that green respiration drops are produced in old cultures, but these have not been observed in subcultures; penicillus sometimes with a more or less divergent cluster of metulae (the *P. citrinum* type), but more often irregular, with a branch or branches from lower nodes, bearing phialides alone or metulae and phialides mixed in the same verticil, sometimes showing the same mixed verticils in the terminal part of the structure; conidiophores long and sinuous, mostly arising from submerged mycelium, rough, 2.5–4μ diam.; rami, when present, rough, 16–25×2.5–4μ; metulae usually 12–20μ long, but shorter, 9–10μ, in the more complicated heads, and 2–4μ diam.; phialides almost cylindrical, tapering abruptly at the tip, very regular in length, 11×2.5–3μ; conidia usually cylindrical (hence the specific epithet), 4.2–5.5×1.8–2.2μ, mostly 5×2μ, but occasionally ovate to ellipsoidal, 3.2–3.5×2.2–2.5μ; conidial chains divergent then tangled, or sometimes in several loose, twisted columnar masses.

"The species is to be classified in the Asymmetrica-Divaricata (Raper and Thom, 1949), and is best placed, at least for the time being, in the *P. lilacinum* series. . . ."

**Penicillium decumbens* Thom var. *atrovirens* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 70. 1956.

"Colonies on Czapek agar are rather restrictedly spreading, attaining a diameter of 25 to 28 mm in 10 to 12 days at 25° C, typically velvety, with a white margin 0.2 mm wide, typically radiately furrowed, sporulating abundantly in blackish yellow-green shades near Dusky Yellow Green or Dull Blackish Green, unchanging or becoming Dark Ivy Green; exudate limited, colorless; odor lacking or slight, moldy; reverse colorless throughout or in slightly greenish shades localized in the central area; conidiophores generally arising in a close stand directly from the substratum or basal felt, sometimes from aerial mycelium, mostly 50 to 120μ or sometimes 250μ long by 1.5–2.5μ in diameter, with apices enlarged to 3.7–6.2μ in diameter, with walls smooth or nearly so; penicilli strictly monoverticillate; sterigmata in

verticils of 7 to 14, parallel or compact, mostly 6.8–9.3μ or up to 13.7μ by 1.7–2.5μ, acute type with smooth walls or nearly so; conidia elliptical to subglobose, mostly 2.4–3.1μ by 1.8–2.5μ, with walls smooth or slightly rough, showing loosely or delicately roughened walls in electron microscopy; chains of conidia in columns or tangled, up to 60–130μ in length.

"Colonies on steep agar spreading, up to 30 to 32 mm. in 10 to 12 days at 25 °C., the other characters as described above for Czapek agar.

"Strains differ markedly from *P. decumbens* Thom in the velvety character of their colonies, and also their blackish yellow-green color."

NOTE: "*P. decumbens* Thom var. *atrovirens* Abe becomes *P. atrovirens* G. Smith." Trans. Brit. Mycol. Soc. 46: 332. 1963.

**Penicillium digitatum* Saccardo var. *latum* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 97. 1956.

"Colonies on Czapek agar grow broadly spreading, attaining a diameter of 65 mm. in 10 to 12 days at 25° C; generally plane or smooth; with 1.2 mm. margin, abundantly sporulating in blue green shades, near Greenish Glaucous blue, and with typical dark blue green shades, near Dark Green, in the central area, becoming Sage Green with age; exudate lacking; odor pronounced, strongly aromatic near citrus fruit fragrance; reverse in dull yellow shades, with surrounding agar colorless; conidiophores arising primarily from the substratum or from basal felt, variable in length, commonly up to 60–320μ in length by 4.0–5.0μ in diameter, with apices enlarged to 4.3–6.3μ in diameter, with walls smooth or nearly so; penicilli biverticillate and asymmetrical, commonly showing one or more branches in addition to the main axis, terminating in verticils of 2 to 4 metulae-bearing sterigmata; branches variable, commonly 12.0–18.7μ in length by 3.1–5.3μ in diameter; metulae usually variable in length, mostly 12.0–2.0μ by 3.1–5.6μ, compact or somewhat divergent; sterigmata in somewhat divergent verticils of 2 to 5, equally variable and ranging from 10.6–18.0μ by 3.1–4.7μ; conidia cylindrical to long elliptical, mostly 3.7–5.6μ by 2.5–3.7μ, and occasionally up to 6.2–7.5μ by 2.5–4.4μ, with smooth walls or nearly so; conidial chains loosely divergent or tangled, up to 60–120μ in length; conidia showing delicately roughened walls in electron microscopy (spines less than 0.1μ).

"Colonies on steep agar grow broadly, 78 mm. in 10 to 12 days at 25° C, with a somewhat broad white margin, 2.0 to 4.0 mm. wide, reverse in brownish shades; the other characters are as described above.

"This strain differs from *P. digitatum* Saccardo primarily in the broadly spreading and luxuriantly growing colonies on Czapek agar, the typical blue-green color of its colonies, and also in the length of its conidiophores (60–320μ)."

NOTE: "*P. digitatum* Sacc. var. *latum* Abe becomes *P. japonicum* G. Smith," Trans. Brit. Mycol. Soc. 46: 332. 1963.

**Penicillium echinosporum* Nehira, Jour. Ferment. Technol. 11: 861. 1933.

"On Czapek's solution agar the mycelium is yellow-green and the margins consist of a 2 mm white border. The colony measures 1 cm in dm after 7 days. In age the white border disappears and the culture becomes a dirty dark-green color; the reverse is bright yellow but sometimes brown in age with yellow-brown zonation. If the culture is floccose when young, it becomes velvety with age. At 33° C. the colony is of a very dark green color with the reverse yellow to brownish-purple. At 37° no growth occurs.

"When examined under a microscope, one may find hyphae in ropes. The width of a hypha is 2–3μ.

"The penicillus is biverticillate-asymmetric, 21–33μ; metulae 8–9μ, sterigmata 10–12μ. The spores are elliptical, 2×3μ, with the ends appearing pointed; some spores are round, 2–2.5μ; they are rough and spiny.

"This fungus belongs to the lanata-typica of the Biverticillata-Asymmetrica and is floccose."
(Translated from the Japanese by N. Wakabayashi.)

NOTE: According to Abe, "a culture was received from Kominami & Tubaki as *P. echinosporum* Nehira; the strain is considered synonymous with *P. verruculosum*." Jour. Gen. Appl. Microbiol., Tokyo 2: 121. 1956.

**Penicillium echinulonalgiovense* Abe (as "*echinulo-nalgiovense*"), Jour. Gen. Appl. Microbiol., Tokyo 2: 81. 1956.

"Colonies on Czapek agar grow rather restrictedly, attaining a diameter of 36 to 37 mm. in 10 to 12 days at 25° C, velutinous or subfloccose, consisting of a fairly close network of vegetative mycelia bearing crowded conidial structures; radially furrowed, with a white or pale yellow margin 1.0 to 2.0 mm. wide; conidial areas in olive or yellow green shades near Olive Green or Lincoln Green, becoming Citrine Drab with age; exudate lacking or limited, colorless; odor limited, moldy; reverse in typical reddish shades near Maroon, Victoria Lake or Hay's Maroon, with surrounding agar in pale yellow or light reddish shades; conidiophores arising primarily from the substratum or from basal felt, and sometimes from aerial hyphae, variable in length, commonly up to 60 to 190 or 380μ long by 2.5–3.3μ in diameter, typically rough-walled, and with apices 3.0–4.4μ in diameter; penicilli biverticillate, asymmetrical and strongly divaricate, consisting variously of occasional branches, metulae and sterigmata, with branches and metulae varying markedly in arrangement and in size; branches variable, commonly 10.0–20.0 or 25.0μ in length by 2.0–3.2μ in diameter, metalue typically divergent, 9.3–15.6 or 20.0μ by 2.1–3.2μ; sterigmata in compact or loosely compact verticils of 3 to 6 or 7, mostly 8.5–10.4 or 12.5μ by 2.1–3.4μ, acute type; conidia ovate (near strawberry form) or subglobose, mostly 2.5–3.8μ, typically echinulate or verruculose walled; conidial chains usually columnar or

loosely tangled up to 30–70 or 130μ in length; and conidia with echinulate or verruculose walls as seen in electron microscopy. Colonies on steep agar (grow) rather more rapidly than on Czapek agar, 47 to 48 mm. in diameter in 10 to 12 days at 25° C; the other characters are as described above.

"These strains differ markedly from *P. nalgiovensis* Laxa, primarily in the usually ovate form of conidia with echinulate or verruculose walls and in the conidiophores mostly 60–380μ in length. The strains also differ markedly from *P. nigricans* (Bainier) Thom, primarily in the olive-green or dull yellow-green colors of conidial areas, in the strongly reddish colors of the reverse, and in the ovate form of the conidia.

"The species clearly belongs in the Biverticillata-Asymmetrica section and is most satisfactorily assigned to the *P. canescens* series, as in the classification of Raper and Thom."

NOTE: "*P. echinulonalgiovense* Abe is *P. janthinellum* Biourge." G. Smith, Trans. Brit. Mycol. Soc. 46: 332 1963.

**Penicillium ellipticum* Sasaki, Jour. Fac. Agr. Hokkaido Univ. 49: 151. 1950.

"Colonies on Czapek's solution-agar restricted, center raised to 1.5 to 3 mm. high, rugose, funiculose, margin white about 1 mm. in width, conidial area tea green (Rdg., XLVII, 25″″), azonate; large colorless drops seen abundantly; reverse of colonies olive-buff (Rdg., XL, 21‴) to olive-gray or dark olive-gray (Rdg., LI, 23‴″) ; substrate uncolored. Conidiophores mostly arising from trailing or anastomosing hyphae, simple or sparingly branched with sterigmata monoverticillate, walls smooth, 2 to 2.5μ in diameter, and to 200μ long when arising from submerged hyphae, up to 10–40μ long as branches of aerial hyphae; sterigmata 10–16×2.5–4μ, 2 to 3 in number; conidia elliptical, faintly spinulose, 3–4.5×1.7–2.8μ; conidial chains parallel or divergent, sclerotia or perithecia not produced.

"Growth on Koji extract-gelatin abundant, rugose, mineral gray (Rdg., XLVII, 25″″) to deep grayish olive (Rdg., XLVI, 21″″) ; reverse dull citrine (Ridg., XVI, 21′) to Kronberg's green (Rdg., XXXI, 25″) ; gelatin liquefied, uncolored.

"Growth on potato abundant, rugose, felted, white with aerial hyphae.

"Milk alkaline but not peptonized."

Penicillium emersonii Stolk (Perfect state: *Talaromyces emersonii* Stolk), Antonie van Leeuwenhoek 31: 262. 1965.

"Colonies on Czapek agar grow somewhat restrictedly, attaining a diameter of 2.5–4 cm in 7 days at 45° C. Usually they grow in a very thin layer, producing limited conidial structures in shades of Olive-Buff to Deep or Dark Olive-Buff (Ridgway, 1912, Pl. 40). Occasionally a few scattered, uncoloured to pale yellow ascocarps are produced.

An exudate occurs in small, clear droplets. The reverse of the colonies is uncoloured, only in the center it becomes Dark Olive-Buff (Ridgway, Pl. 40).

"Colonies on malt agar grow rapidly, attaining a diameter of 7–9 cm. in 7 days at 45° C. The mycelium is hyaline, partly submerged, partly aerial, appearing definitely funiculose. Ascocarps are abundantly produced, showing yellow shades near Colonial and Deep Colonial Buff (Ridgway, Pl. 30), at maturity becoming orange brown to somewhat red, ranging from Clay Color to Fawn Color (Ridgway, Pls. 29, 40). They are intermixed with and overgrown by pale brown conidial structures, near Dark Olive-Buff and Avellaneous (Ridgway, Pl. 40). A colourless to cream coloured exudate is produced in small droplets. The reverse of the colonies shows brown shades.

"Hyphae are hyaline, 1–3μ in diameter.

"Conidiophores arise primarily from submerged hyphae but they are also borne as perpendicular branches from aerial hyphae or ropes of hyphae. Many of them originate from short cells, reminiscent of the foot-cells of *Aspergillus*. Conidiophores are hyaline to pale yellow, erect, septate, 35–150μ in length, 3–4.5μ in diameter, with coarsely roughened walls. Penicilli are of the Asymmetrica type. They are somewhat irregular in pattern, sometimes consisting of only one compact to slightly divergent, terminal verticil of three to five metulae, but frequently they show one or two branches in addition to the main stalk. The different elements of the penicillus are hyaline to slightly yellow coloured. Branches are rough, (12–25) × (2.5–3)μ, often showing inflated apices, up to 6μ in diameter; occasionally they are rebranched. Metulae are very rough, 10–12μ long, 2.5–3μ in diameter, with inflated apices up to 6μ in diameter. Phialides are almost cylindrical, tapering abruptly to short conidium-bearing tips up to 2μ in length. They are parallel-ranged, occurring in crowded clusters about five to ten to the metula, measuring (9–12) × (2–2.5)μ. Phialide walls are commonly smooth, but occasionally they appear roughened. Conidia are smooth, hyaline to pale brown, mostly cylindrical, sometimes swelling at maturity and becoming ellipsoid (3.5–6) × (1.5–3)μ, rarely up to 12μ in length. They are produced in long, loosely adherent to parallel chains, often forming loose columns. Ascocarps are abundantly produced on malt agar and oatmeal agar; they form mostly an almost continuous layer at the agar surface. They are variable in shape and dimensions, usually confluent, but when borne separately, they are globose to ellipsoid, mostly 50–300μ in diameter. Ascocarps are soft in all stages of development, yellow coloured when young, becoming avellaneous to orange brown when old. A definite, entire peridial wall is lacking, only a thin network of interwoven, yellow hyphae is present especially at the base of the ascocarp where it may appear somewhat pseudoparenchymatous. Ascocarps are surrounded by loose wefts of radiating, twisted, hyaline to pale yellow hyphae (about 1μ thick), producing a conspicuously pilose appearance at low magnifications. Asci are produced abundantly throughout the ascocarp; they are borne in short chains though occasionally a few asci occur that are developed singly. Asci are evanescent, subglobose to ellipsoid, 8-spored, (8–9) × (6–8)μ. Ascospores are subglobose, (3.5–4.3) × (3–3.5)μ, smooth or nearly so, definitely yellow coloured. In young cultures conspicuous,

swollen cells have been observed, which take up stains very easily. They always occur in connection with ascocarpic initials and though their exact function could not be demonstrated, they may represent ascogonia.

"The fungus does not grow at 25°C. At 30°C. a slight development occurs with only a few abnormal conidial structures and a very few ascocarps. From 35° C. to 50° C. the fungus develops well, producing both ascocarps and penicilli in abundance. Optimal development occurs at 40°–45° C. Limited growth results at 55° C., at which temperature only the conidial stage is produced. None of the examined strains develops at 60° C.

"*P. emersonii* resembles in some respects the non-thermophilic imperfect fungus *Penicillium cylindrosporum* Smith. The penicilli of both species show conspicuously roughened cell walls, they both produce avellaneous, cylindrical conidia and phialides of the same shape. The penicillus of *P. cylindrosporum*, however, shows more divergent structures."

**Penicillium estinogenum* Komatsu and Abe apud Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 132. 1956.

"Colonies on Czapek agar grow rather rapidly, spreading, attaining a diameter of 40 to 50 mm. in 10 to 12 days at 25° C., consisting of a comparatively hard and thin basal felt bearing crowded conidial structures, typically velvety, with surface radially furrowed, a white margin about 1.0 mm. wide, conidial areas in dark yellow green shades, near Dark American Green becoming Ivy Green or Light Brownish Olive; exudate limited, in pale yellow shades; odor lacking or limited, moldy; reverse in dull yellow or olive shades, becoming olive in the central area and brownish or brownish olive in the marginal areas; surrounding agar yellow or pale greenish; conidiophores arising primarily from the substratum or from basal felt, commonly 90–180μ in length by 2.5–5.2μ in diameter, with apices 4.0–5.9μ in diameter, and slightly roughened walls; penicilli biverticillate and symmetrical, usually consisting of a single verticil of 4 to 6 metulae, each terminating in verticils of 4 to 7 sterigmata, metulae mostly 10.0–15.2μ in length by 2.4–3.6μ in diameter, loosely compact or somewhat divergent; sterigmata compact, mostly 8.0–12.0μ by 2.1–3.0μ, and narrowly tapered; conidia elliptical or ovate, mostly 3.0–4.0μ by 2.5–3.1μ, with granular or verruculose walls; conidial chains tangled or loosely parallel, up to 60–130μ in length; and conidia showing granular or verruculose walls in electron microscopy.

"Colonies on steep agar grow rather broadly, 46 to 62 mm. in 10 to 12 days at 25° C; the other characters are as described above.

"These strains differ markedly from *P. herquei* Bainier and Sartory primarily in the typically granular or verruculose conidial walls, in the infrequent production of beak-like sterigmata, and in the rarely observed suggestively divaricate arrangement of metulae.

"The strains also differ markedly from *P. novae-zeelandiae* van Beyma primarily in the typical elliptical form and granular or verruculose walls of the conidia.

"The correct placement of the species remains in doubt, but it appears to be most satisfactorily assignable to (the *P. herquei* series) in the Biverticillata-Symmetrica as in the classification of Raper and Thom."

NOTE: G. Smith (Trans. Brit. Mycol. Soc. 46: 335. 1963) provided a Latin diagnosis for this species, the complete name of which is now *P. estinogenum* Komatsu and Abe ex G. Smith.

**Penicillium fellutanum* Biourge var. *nigrocastaneum* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 71. 1956.

"Colonies on Czapek agar are rather restrictedly spreading, attaining a diameter of 23 to 24 mm. in 10 to 12 days at 25° C, typically velvety or velutinous, with a white narrow margin, 0.2 mm. wide, buckled and typically radiately furrowed, sporulating abundantly in dark blue-green shades near Dark Russian Green, becoming blackish green; exudate lacking; reverse colorless in marginal area and drab in the central area, localized, turning to pink in the marginal area and Clove Brown in the localized control area; conidiophores generally arising from a basal felt, or sometimes trailing or prostrate creeping hyhae, mostly 40–120μ long by 1.7–2.0μ diameter, with apices enlarged to 3.0–4.3μ in diameter, and smooth walled or nearly so; penicilli strictly monoverticillate; sterigmata in verticils of 6 to 12, parallel, mostly 10.0–13.2μ by 2.1–3.1μ, acute type; conidia elliptical to subglobose, mostly 2.5–3.4μ by 2.1–2.8μ, with walls smooth or slightly rough and loosely or delicately roughened walls shown by electron microscopy; chains of conidia in loose columns or parallel, up to 30 to 120μ in length.

"Colonies on steep agar are spreading, growing to 28 to 29 mm. in 10 to 12 days at 25° C, elevated in the central area; other features are as described above.

"(These strains) seem to be similar to *P. fellutanum* Biourge. However, they differ markedly from *P. fellutanum* in the velutinous character of their colonies, the dark blue-green color changing to blackish-green, the growth at 37° C, the length of their sterigmata, the production of a strongly brownish-red color in the colony reverse, and the production of a strongly red (near Grenadine Red) color of their broth by surface color."

NOTE: "*P. fellutanum* Biourge var. *nigrocastaneum* Abe, is not separable from *P. fellutanum;* the varietal epithet should be dropped." G. Smith, Trans. Brit. Mycol. Soc. 44: 332. 1963.

**Penicillium fuscoflavum* Abe (as "*fusco-flavum*), Jour. Gen. Appl. Microbiol., Tokyo 2: 64. 1956.

"Colonies on Czapek agar grow rather heavy but restrictedly, attaining a diameter of 8 to 10 mm. in 10 to 12 days at 25° C; texture velutinous in marginal to subcentral colony area but somewhat subfloccose in central area, colony smooth or plane and somewhat raised

in the center; conidial area in blackish yellow green shades near Dusky Yellowish Green with lighter shades in the narrow, thin margin; exudate lacking; reverse colorless; conidiophores with punctate walls arising from the substratum, usually 15.0–30μ by 2.2–3.7μ, apices enlarged, to 3.7–6.2μ in diameter; penicilli strictly monoverticillate; sterigmata mostly somewhat divergent, in verticils of 3 to 8, 6.2–7.5μ by 1.7–3.0μ, smooth walled or nearly so; conidia elliptical to subglobose, mostly 3.7–6.0μ by 3.0–4.0μ, with conspicuously echinulate or verruculose walls; chains of conidia tangled, up to 30–60μ in length; and conidia showing conspicuously echinulate or verruculose walls in electron microscopy.

"Colonies on steep agar are heavy and restrictedly spreading, up to 10 mm. in 10 to 12 days at 25° C; the other characters are as described above.

"The strain differs markedly from *P. fuscum* (Sopp) Raper and Thom, in the very restricted character of its growth, in the blackish yellow green color of its colony and also in its long elliptical conidia.

"The correct placement of the species remains in doubt, but it appears to be most satisfactorily assignable to (the *P. restrictum* series) in the Monoverticillata."

NOTE: "*P. fuscoflavum* Abe is *Aspergillus restrictus* G. Smith," G. Smith, Trans. Brit. Mycol. Soc. 46: 332. 1963.

Penicillium glaucocinerascens Chalabuda, Not. Syst. Crypt. Inst. Bot. Acad. Sci., U.S.S.R. 6: 165. 1950.

"Colonies on Czapek's agar tomentose, limited growth, gray-olivaceous, clear yellow exudate, reverse orange. Colonies on sugar beet root extract agar tomentose (lanose), more or less rounded, at first creamy-white, later ashen-olivaceous; very small exudate drops, numerous, clear, uncolored; reverse orange-brown, conidiophores 90–100$\times$2μ commonly very slightly roughened, ends divaricately branched; sterigmata 7$\times$1.6–2μ. Conidia ellipsoid, smooth, 2.5–3$\times$1.8–2μ, yellow-olivaceous in mass."
(Translated from Latin diagnosis.)

Penicillium glaucolanosum Chalabuda, Not. Syst. Crypt. Inst. Bot. Acad. Sci., U.S.S.R. 6: 167. 1950.

"Colonies on Czapek's agar minute, ash-colored, densely tomentose, but not in marginal zone; reverse clear yellow-olivaceous or rose-colored; on sugar beet root extract agar densely tomentose, white-ashen; reverse dirty brown; conidiophores 19–50$\times$2.5–3μ, simple, very slightly roughened, arising from creeping hyphae, tips 3–5μ, sterigmata 6.5–8$\times$2–2.5μ. Conidia hardly ellipsoid or globose, smooth, olivaceous in mass, 2.5–3.5μ."
(Translated from Latin diagnosis.)

**Penicillium griseo-azureum* Moreau, Rev. Mycol. NS, VI, p. 59, 1941.

"It forms a smooth mat on nutritive agar, producing a gray-blue color at the margin, becoming mouse gray; the culture develops a yellow pigment underneath (reverse).

"The mat in the center consists of erect conidiophores, short, clustered, simple or a little branched at the tips. The end bears the sterigmata which rise above the terminal parts, which by no means are scarcely inflated while young, more visibly inflated in heads when the number of sterigmata increases beyond a few units. These heads become up to 4μ in dm.

"The sterigmata are conspicuous for their short form, inflated, pointed at the tips; their dimensions are 5×3μ, and the surfaces are finely dotted.

"The pigmentation of the cultures is due to the presence of coloring material in the cell walls or in the cytoplasm. The spore walls uncolored while young, become dirty green then green-yellowish. In the cytoplasm of surface hyphae, a sky-blue pigment is often diffused, especially abundant in the sterigmata and spores, more is also present in the hyphae; the blue pigment is scattered in all the cytoplasm, more especially localized in the oil globules. The color of the cultures and its variations are linked to the relative proportions of the two tints green and blue.

"At length the hyphae are rich in an oil in which is dissolved a yellow coloring substance; this is the cause of the yellow color in the culture reverse."

(Translated from the French.)

Penicillium griseolum G. Smith, Trans. Brit. Mycol. Soc. 40: 485. 1957.

"Colonies on Czapek agar spreading moderately quickly but extremely thin, transparent, showing no visible mycelium but only scattered penicilli, giving a very faint greenish hue to the colony; on malt agar or potato-dextrose agar growing moderately well, at first pale grey with broad white edge, turning darker grey, matted funiculose about 1 mm. thick; reverse brown with a greenish tone (somewhat like mustard but rather darker and duller); penicilli strictly monoverticillate; conidiophores arising from aerial hyphae, very short, smooth, 12–35×1.2–2μ; phialides few in the verticil, abruptly pointed, 6–7×1.62μ; ripe conidia globose or nearly so, faintly verrucose, 3.1–4.0μ diam. but mostly in the range 3.2–3.5μ, in parallel chains or forming somewhat loose columns; young conidia oidium-like, small, cylindrical, swelling only slowly and remaining in chains attached to the phialides, even on mounting in fluid.

"This species belongs to the Funiculosa section of the Monoverticillata, in the *P. adametzi* series, and closest to *P. terlikowskii* Zaleski, from which it differs in its very poor growth on Czapek agar, in its lack of green color on malt agar, in its different reverse color, and in

the curious tendency, conspicuous otherwise only in *P. italicum*, to form oidium-like chains of very slowly ripening conidia."

Penicillium griseopurpureum G. Smith, Trans. Brit. Mycol. Soc. 48: 274. 1965.

"Colonies on Czapek agar growing somewhat slowly, 16–17 mm. diam. in 7 days at 24°, bluish grey green at first, rapidly becoming almost pure grey, with no white margin, thick velvety, with reverse at first dull purple, not diffusing, becoming very dark brownish purple; colonies on malt agar growing slightly more rapidly, 20 mm. diam. in 7 days, slightly funiculose, coloured as on Czapek agar, with reverse deep dull purple, diffusing somewhat; penicilli consisting of whorls of metulae, somewhat divergent, and often unequal in length in a single verticil, occasionally with a secondary branch from the next lower node of the conidiophore, this bearing phialides only or with a small cluster of metulae each bearing phialides; conidiophores arising mostly from the substratum, usually about 500μ long and 2.4–3.2μ diam., slightly rough; metulae 8–18×2.5–3.5μ; phialides with fairly longpointed tips, 10×2–2.2μ, conidia globose to subglobose, slightly rough, 2.2–2.6μ diam., in chains, at first divergent or in ill-defined columns, becoming more or less tangled.

"This species is to be classified either in the Biverticillata-Asymmetrica or in the Divaricata, and is distinguished by the purple reverse of colonies and by its small conidia."

Penicillium hirayamae Udagawa, Jour. Agr. Sci. Tokyo Nogyo Daigaku 5: 6. 1959.

"Colonies on Czapek agar growing rather restrictedly, tomentose to somewhat funiculose, consisting of a reddish yellow mycelial felt overlaid by a network of trailing and interlacing hyphae and ropes of hyphae, with irregular production of conidial structures, often appearing massed in sectors, in grayish green shades near dark porcelain green to dusky green (Ridgway, 1912), immature sclerotia scattered only in localized areas, reverse pale yellow. Conidiophores 30–50× 2.5–3μ, borne as short branches from closely interwoven aerial hyphae, septate, smooth. Penicilli strictly monoverticillate. Sterigmata 3–8 in the verticil, mostly 6.5–8×2μ, with condium-bearing tips more or less abrupt. Conidia ellipsoid to subglobose, 2.5–3.2×2–2.5μ, walls smooth and comparatively heavy, in loose parallel chains up to 100μ or more in length.

"On malt agar, rapidly growing, more definitely funiculose, consisting of a fairly close, thin layer of sclerotia with yellow encrusted sterile hyphae, overgrown but not obscured by a loose network of aerial hyphae, conidial areas in blue green shades near Russian green, margins dissected, reverse light cadmium to apricot yellow. Sclerotia at first cadmium yellow to orange, often becoming dark-colored in age, spherical to subspherical, 200–350μ, in diam., consisting of thick-walled polygonal cells, hard.

"At 37° C, conidial structures not produced."

NOTE: D. B. Scott and Amelia C. Stolk reported in "Antonie van Leeuwenhoek" 33: 305, 1967, that this taxon has a perfect stage, which they named *Eupenicillium hirayamae*. Their description of this stage is given as follows:

"Cleistothecia are spherical to subspherical, 200–300μ in diameter. They are surrounded by very thin wefts of highly pigmented and encrusted hyphae, yellow-orange when young, but darkening slowly in age. In their young stage they are very hard, consisting of sclerotioid masses of thick-walled polygonal cells. After 5 to 6 weeks asci begin to appear in the centre. Ripening continues from the centre outwards till the ascocarp is almost completely filled with ascospores. Mature ascocarps show an outer wall which consists of a single layer of cells. Asci are borne as lateral buds or branches from fertile hyphae which appear in the centre of the ascocarp, chains were not found. They are globose to oblong, 6–7μ at maturity, and contain 8 spores. Ascospores are yellow, lenticular, rather small measuring 2.2–2.7μ by 1.5–2.0μ, with walls finely roughened and with two small and closely appressed but clearly distinct equatorial ridges.

"The fact . . . that ascospores are consistently produced in all isolates examined, places this species in the genus *Eupenicillium* or in the *P. javanicum* series of Raper and Thom (1949)."

Penicillium impar V. Szilvinyi, Zentbl. f. Bakt., Parasitenk., u. Infektionskrank 103: 164. 1940–41.

"On Czapek's agar after 7 days, (colonies are) round, finely-wooly, pad-shaped, dark sap-green, compared to the edge which is verdigris but later is white and sharp-edged against the agar. Copius, large, hyaline guttation drops; after 10 days, the oldest areas are yellow-green to gleaming-brownish, with a finely-wooly overlayer. Exudate golden-yellow in places; after 14 days (the colonies are) finely-wooly to floccose, dark to brightly yellow-green with a whitish edge. Copius guttation. Reverse pale yellowish. (There is an) indication of zonation. Size of the colony: 10 mm after seven days, 25 mm after ten days. Conidiophores smooth, hyaline, dm. 3–4μ, (penicilli divaricate), metulae 5×2μ. Sterigmata likewise 5×2μ. Conidia smooth, round, dm. 2.5μ, in open chains. Minimum temperature for growth is 8° C., optimum temperature is 26° C., and maximum is 26°–36° C."
(Translated from the German.)

Penicillium indicum D. K. and R. S. Sandhu, Canad. Jour. Bot. 41: 1273. 1963.

"Colonies growing rapidly on Czapek's agar, reaching a diameter of 5 cm in 10 days at 25° C, plane but raised and somewhat fluffy in the center, white at first and then becoming grayish green after the development of abundant penicilli. Sclerotia abundant, lending color to the colony. Exudate abundant and colorless. Penicilli monovertic-

illate, conidial chains thin, columnar, slightly loose, 109–272μ by 20μ. Conidiophores arising from the aerial hyphae, short, smooth, 17–39μ in length, 1.7–2.5μ in diameter, uncolored to slightly greenish, apices of the conidiophores enlarged like vesicles 3.4–6.5μ in diameter. Sterigmata parallel, crowded, up to 15 per vesicle, 6.8–8.4μ by 1.7μ. Conidia globose to subglobose, 1.7–2.5μ in diameter, smooth walled. Sclerotia globose to subglobose, white to cream colored, produced throughout the colony, soft, easily crushed, composed of thick-walled pseudoparenchymatous cells and not enveloped by hyphae, 55–150μ in diameter.

"Colonies on cornmeal agar very thin spreading 5 cm in 10 days, grayish green, sclerotia produced in small numbers, clustered in small groups or present singly, conspicuous, penicilli as on Czapek's agar.

"Colonies on malt agar spreading, 5.5 cm in 10 days, sporing heavily, slightly powdery, grayish green, producing abundant sclerotia which do not lend color to the colony, penicilli as described above.

"The outstanding characters of *P. indicum* are the smooth and short conidiophores arising from aerial hyphae, monoverticillate penicilli, smooth and globose conidia, and the production of soft, white to creamy sclerotia scattered all over the colony and not surrounded by an envelope of hyphae. On the basis of these characters *P. indicum* should naturally be placed in the *P. thomii* series in the Monoverticillata Section of Raper and Thom (1949). But it is clearly marked from all the hitherto known species including *P. pinetorum* (Christensen and Backus, 1961), another monoverticillate form described recently and probably also belong to the *P. thomii* series.

"*P. indicum* has some resemblance to non-sclerotial *P. decumbens* Thom."

(According to Dorothy I. Fennell, who examined a culture of *P. indicum* at the authors' request, "The conidial structure and general growth habit are quite similar to *P. decumbens* but this species has never been known to produce sclerotia. The present members of the *P. thomii* series do not include a species which produces the white to cream sclerotia developed by this isolate.")

Penicillium isariiforme Stolk and J. Meyer, (*as* "*isariaeforme*"), Trans. Brit. Mycol. Soc. 40: 187. 1957.

"Colonies on Czapek agar in Petri dishes grow well, attaining a diameter of about 4 cm. in 14 days at room temperature (20° C.). They are extremely fasciculate, consisting of a fairly tough, somewhat funiculose but essentially plane basal felt from which the *Isaria*-like coremia arise in conspicuous concentric zones. The basal felt, generally somewhat raised in central areas, bears loosely scattered, separate penicilli in pale yellow green shades near Dull Green Yellow (Ridgeway, 1912) and Deep Sea-foam Green becoming Drab in age. The colony margin is in very young cultures even with advancing zone white and somewhat fibrous owing to developing coremia. Older colonies often become star-like on account of the growth of the exterior coremia. The coremia are fibrous, mostly simple, 1–4 mm. in diameter

throughout and up to 15 cm. long in a liter Erlenmeyer flask. The coremia are not differentiated into a stalk and a spore-bearing tip, they are at first white to Light Chalcedony Yellow, but soon develop yellow green shades near Light Hellebore Green and Cress Green becoming Jade Green or Olive in age. Growing coremia are characterized by conspicuous white tips. Often the stalks are zonate, fertile green bands alternating with sterile yellow ones. The coremia are strongly positively phototropic. Areas of flocculent, sterile, white or pale yellow overgrowth may develop in older cultures, thus altering the cultural aspect of the colony. This occurs especially in tubes and in Erlenmeyer flasks containing a deep layer of culture medium. Exudate in pale yellow drops. Odour mouldy. Reverse in yellow shades, near Light Chalcedony Yellow, beneath the coremia Light Grayish Olive and in the centrum becoming Deep Olive-buff in age. The penicilli are abundantly produced along the coremia, sometimes individually hardly distinguishable, with elements closely crowded and interlaced, forming a hymenium-like spore-bearing surface. The penicilli are mostly composed of well-differentiated—but irregular—asymmetric structures, showing usually one or more sinuous, divergent branches on different levels in addition to the main axis, or bearing only a single terminal verticil of metulae. Secondary penicilli arising from branches are often monoverticillate. Conidiophores sinuous, with smooth walls, mostly short, about 30–100μ in length, but sometimes up to 350μ, and 3–4μ in diameter. Branches sinuous, smooth, 10–25$\times$2.5–3μ. Metulae usually in groups of two to four, measuring 9–15$\times$3–3.5μ, somewhat divergent, inflated at the apices. Sterigmata few to the metula, commonly in groups of two to seven, conspicuously parallel, giving the surface of the coremia its palisade-like appearance, 12–16$\times$2.5–3.5μ, of an almost constant diameter throughout, gradually tapering into conidium-bearing tips in a manner suggestive of the Biverticillata-Symmetrica. Conidium-bearing tubes of the sterigmata cup-like, thus designating the sterigmata as phialides. Conidia elliptical, with one or both ends pointed, 3–3.8$\times$2–2.5μ, with walls delicately spinulose, abundantly produced in tangled chains.

"Colonies on malt agar show a conspicuous tendency to develop areas of flocculent, sterile overgrowth, coremia and penicilli as described above.

"On account of its strongly coremiform aspect and its irregular, asymmetric penicilli, the fungus must be placed in the *P. claviforme* series (Raper and Thom, 1949). Within this series it is nearest to *P. clavigerum* Demelius, since this species is characterized by sterigmata of the same general character. Our fungus is distinguished from *P. clavigerum* by the much larger coremia, by the conspicuous yellow color of the mycelium, and by the somewhat pointed, spinulose conidia."

Penicillium italicum Wehmer var. *album* Wei, Nanking Jour. IX, p. 241. 1940.

"The fungus produces vigorous white mycelium on agar medium. Both velvety fruiting layer and coremium were formed with the latter

forming a ring near the center. Fructifications are all pure white. The morphology of the conidiophores resembles closely that of *P. italicum* with sterigmata measuring 8.4–12.6×1.8–4.2μ. Conidia are ovate to oblong, mostly ovate, measuring 3–8.4×2–5.7μ.

"The present fungus is, however, a mutant of *P. italicum* to which it agrees both in morphological characters and reaction to temperature."

Penicillium japonicum G. Smith. (Syn. *P. digitatum* Saccardo var. *latum* Abe), Trans. Brit. Mycol. Soc. 46: 333. 1963.

"Colonies on Czapek agar spreading rapidly and broadly, velvety, rather pale blue-green, with a very broad margin consisting of a loose web of interlacing hyphae, almost white; reverse reddish brown except that there is often a central spot which is almost colourless; penicilli typically asymmetric, either consisting of a compact cluster of metulae and phialides, or having two to several rami bearing the metulae, or occasionally very large and complex with four stages of branching, the total length being 50–80μ; conidiophores mostly arising from the submerged mycelium, smooth, often sinuous, 3–4μ diam.; metulae variable but mostly 10–16×3–4μ; phialides remarkedly uniform in length, 12×2.8–3.0μ; conidia very variable in size and shape, mostly ovoid to elongate, occasionally pyriform, smooth or with a slightly uneven surface, 3.5–7×3–4μ, in chains, roughly parallel at first, then tangled."

Penicillium kewense G. Smith, Trans. Brit. Mycol. Soc. 44: 42. 1961.

"Colonies on most of the usual culture media similar, spreading somewhat slowly, consisting almost entirely of perithecia, showing a faintly blueish zone of conidial fructifications only in very young cultures, avellaneous (Ridgway Pl. XL), with numerous reddish drops during the growing period; reverse deep reddish brown with the colour diffusing somewhat into the agar; perithecia 190–280μ diam., irregularly globose to ovoid at first sclerotium-like, ripening very slowly from the centre outwards producing ripe spores in 4–5 weeks; asci pear-shaped when young becoming ovoid when fully ripe, formed in chains, 8-spored, 9–10×6–7μ, ascospores broadly ovoid with two well-separated equatorial frills, and with the curved surfaces coarsely roughened, 4.2–5×3–3.2μ; penicilli asymmetric, compact, with sometimes three stages, sometimes four stages of branching, when 4-verticillate usually with ramuli and metulae in the same verticil, commonly with 2–3 rami; conidiophores long, smooth mostly 4.0μ diam.; rami 20–22×3–4μ; metulae 10×3–3.5μ, slightly swollen at apex; phialides 9.5–10×2–2.2μ; conidia mostly somewhat pear-shaped (appearing globose or subglobose when seen end on), very slightly roughened, 2.8–3×2.3–2.5μ, in chains forming compact masses almost columnar.

"In general appearance of culture, *P. kewense* is similar to *P. baarnense* van Beyma. It differs from the latter in producing more pigment

in reverse of colonies, also in having ascospores which are smaller and with different ornamentation. The two differ also very markedly in their conidial fructifications."

Penicillium kojigenum G. Smith, Trans. Brit. Mycol. Soc. 44: 43. 1961.

"On Czapek agar grows moderately well, velvety, at first pale blueish green, then developing dark grey-green shades from the centre outwards; margin somewhat fimbriate, white; reverse uncoloured; conidiophores long, smooth, 2.5–3μ diam., showing a slight tendency to fasciculation; penicilli mostly 3 times verticillate, with 2–3 rami 20–30μ long, but sometimes with metulae and phialides in the same verticil, hence partially 4-verticillate, sometimes with a secondary branch from a lower node, occasionally with one of the rami bearing phialides directly; metulae 11–13$\times$2.5–3μ; phialides 10$\times$2–2.2μ; conidia globose to sub-globose, rough, 2.2–2.6μ diam., in chains which are at first divergent then tangled."

Penicillium kurssanovii Chalabuda, Not. Syst. Crypt. Inst. Bot. Acad. Sci., U.S.S.R. 6: 164. 1950.

"Colonies on Czapek's agar growing slowly, round, white, somewhat tomentose; reverse white. Colonies on sugar beet root extract agar broadly tomentose, at first white, quickly pale gray-rose, growing rapidly; abundant exudate, minute, pale-rose, mycelium white-rosy; reverse initially pale brown, then pale brown-vinaceous with the agar of similar color; conidiophores 19–30$\times$2.5μ arising from creeping hyphae, simple, tips bearing 4–5 sterigmata, 11.5$\times$2.8–3μ; conidia at first ellipsoid then globose, smooth, hyaline, 3–4μ."
(Translated from Latin diagnosis.)

Penicillium lapidosum Raper and Fennell, Mycologia 40: 524–525. 1948.

NOTE: D. B. Scott and Amelia C. Stolk reported in "Antonie van Leeuwenhoek" 33: 298, 1967, that this taxon has a perfect stage which they named *Eupenicillium lapidosum*. Their description of this stage is given as follows:

"Cleistothecia are more or less spherical, up to 500μ in diameter and orange-brown in colour, becoming dark red-brown near±Cinnamon-Rufous (R. Pl. 14) with age. In the early stages they show no apparent differences from true sclerotia. They are extremely hard and consist of thick-walled sclerenchymatous tissue throughout. The ripening process is delayed for several weeks and 6 weeks or more may elapse before asci appear in the centre of the ascocarpic body. In some cases ascospores are apparently not produced at all. Cleistothecia develop ascospores from the centre outwards and when they are matured a

few layers of cells on the outside remain intact. Asci are borne singly on terminal or lateral branches of fertile hyphae. They are spherical to oval or oblong, 10–12μ in diameter or up to 15μ in long axis when oblong, and contain 8 spores. Ascospores are slightly yellow when matured and lenticular in shape. They consist of a central spore body, measuring 4.5–5.5×3.5–4.5μ and ornamented by two prominent and broadly separated equatorial ridges about 1μ or more in width. The convex surfaces of the spores show spine-like projections, sometimes so oriented that they suggest one or more smaller secondary ridges. The overall dimensions of the ascospores are 5.5–6.5×3.5–4.5μ.

"The correct position of this species in the Raper and Thom classification is obviously in the *P. javanicum* series. It resembles *Eupenicillium parvum* in certain respects such as colours of the colonies, and the late ripening of the ascocarps. It is easily distinguished from *E. parvum* by its rapid growth on most media and by the form and dimensions of its ascospores."

Penicillium liani Kamyschko, Not. Syst. Crypt. Inst. Bot. Acad. Sci., U.S.S.R. 15: 86. 1962.

"Colonies on Czapek's agar after 10 days are 4 cm in dm., surface velvety-tomentose, granular because of numerous cleistothecia, yellow; aerial hyphae slightly rose-colored. Exudate of brown drops, watery. Reverse of creamy color, pale dry purple, sometimes darkening. Conidiophores few, born on aerial hyphae, rough-shaped (?), frequently monoverticillate, sometimes asymmetric and biverticillate, 20–35×3μ, sometimes 65μ long. Metulae 12–16×2–2.5μ. Sterigmata 15×2–2.5μ, tips greatly narrowed, crowded in verticils of 3–4. Conidia lemon-shaped or oval, 3–3.5×2.5–3μ, smooth, at a distance briefly catenulate. Cleistothecia extremely numerous, yellow, smooth, round, immersed in tomentose aerial mycelium, no membrane, intricately wrapped up in compressed hyphae, to 0.5–0.6 mm in dm., maturing within 12–14 days. Asci circular 10μ in dm., membrane somewhat inconspicuous botryose, occasionally clustered in 2–3 chains, 8-spored. Spores oval, spore wall usually setose, 4.5–5×3.5–4.5μ.

"On fresh wort agar after 10 days, colonies are 6 cm. in dm., yellow, scarcely rose. Cleistothecia very abundant, 0.5–0.6 mm in dm. No exudate. Reverse colored dark-brown. Conidiophores solitary.

"On corn agar, colonies after 10 days are 6 cm. in dm., low, thin, pale brown. Exudate absent. Reverse brown colored."
(Translated from Latin diagnosis.)

**Penicillium lilacinoechinulatum* Abe (as "*lilacino-echinulatum*"), Jour. Gen. Appl. Microbiol., Tokyo 2: 54. 1956.

"Colonies on Czapek agar grow rather restrictedly, about 30 mm. in 10 to 12 days at 25° C; the central area is raised, and sulcate, the surface appearing typically funiculose, in pale gray green shades near Mineral Gray or Pale Olive Gray, changing to Tea Green; exudate abundant, colorless; reverse in near Light Vinaceous Lilac in 6 to 7

days, changing to yellow shades, and the surrounding agar in pale yellow shades; penicilli strictly monoverticillate; conidiophores short, up to 20–40μ in length by 1.2–1.9μ in diameter, with walls smooth or nearly so, and apices enlarged up to 3.0–6.2μ in diameter; sterigmata in crowded clusters, numbering 6 to 15 in a verticil, mostly 5.0–7.0μ or rarely 9.3μ in length by 1.5–2.5μ in diameter, acute type with smooth walls or nearly so; conidia globose to sub-globose, with typically echinulate or verruculose walls, mostly 2.1–2.8μ in diameter; chains of conidia in parallel or loose columns, commonly up to 30 to 60μ in length; and conidia showing conspicuously echinulate or verruculose walls in electron microscopy.

"Colonies on steep agar are restricted, growing to about 37 mm. in 10 to 12 days at 25° C; the other characters are as described above.

"This strain is separated from *P. restrictum* Gilman and Abbott and related species by the typically funiculose character of its colonies, their color, and the character of rarely growing on Sakaguchi and Wang agar.

"The strain also differs markedly from *P. terlikowskii* Zaleski in the pigments developed in the colony reverse, and in the character of the walls and sizes of the conidia.

"The correct placement of the species remains in doubt, but it appears to be most satisfactorily assignable to (the *P. adametzi* series) in the Monoverticillata."

NOTE: G. Smith (Trans. Brit. Mycol. Soc. 46: 335. 1963.) provided a Latin diagnosis for this species, the complete name of which is now *P. lilacinoechinulatum* Abe ex G. Smith.

Penicillium luteo-aurantium G. Smith (as "*luteoaurantium*"), Trans. Brit. Mycol. Soc. 46: 331. 1963.

"Colonies on Czapek agar grow fairly rapidly, eventually spreading widely, are velvety, at first bright yellow, then somewhat deeper yellow, slowly developing irregular patches of gray-green, with a colourless fimbriate margin, and reverse broadly zoned, bright orange and eventually almost scarlet; penicilli mostly monoverticillate, but sometimes with a small cluster of metulae, i.e. verging towards the *P. citrinum* series, sometimes more truly divaricate, with sparing but irregular branching; conidiophores smooth, arising from creeping aerial hyphae, short or very short, mostly 10–40μ, seldom longer, and 2.0–2.2μ diam., slightly swollen at the tip if no metulae are present; metulae, when present, 11–13×2.8–3.0μ, slightly swollen at the tip; phialides with fairly long tapering tips, but definitely not acuminate, as in the Biverticillata-Symmetrica, 9–11×2.5–3.0μ; conidia subglobose to broadly ovoid, delicately roughened, mostly 2.8–3.0×2.0–2.5μ, but occasionally 4–5×3.0–3.8μ or about 3.5μ diam., in chains which are at first parallel then tangled.

"Colonies on malt agar grow rapidly, sporing more readily than on Czapek agar, but otherwise similar.

"The correct placement of this species in the Raper and Thom classification is not easy to determine. In view of the fact that some of the

penicilli are branched, its probable place is in the Divaricata, but it would need to be keyed also in the Monoverticillata."

**Penicillium luteocaeruleum* Saito and Minoura, Jour. Ferment. Technol. 27 (1–3): 6. 1949.

"This fungus presents a different color and appearance depending on the culture substrate and other conditions. It grows well on Czapek's solution agar, corn steep agar, and on several other agars. It grows well at 25° C, but not at 37° C. Normally, sporulating cultures are blue-green to blue to gray; sometimes there are yellow areas. The cultures that have sporulated poorly are deep yellow to yellow-red in color. The culture reverse is yellow at first but gradually darkens, finally changing to blue-green; however the borders are a bright yellow. The conidiphores are unbranched and they bend somewhat near the top edge; their diameter is about 3μ. They are colorless or yellow and their surface has a large number of rough particles. The penicillus is Biverticillate-Symmetric and is typically double-ranked with verticils of 3–5 metulae, each metula is $10\times5\mu$; sterigmata are 10×3–4μ. Metulae and sterigmata are usually colorless but occasionally they are yellow or blue. The spores are oval with a smooth surface and are borne in a long chain; the spore measures $4\times2.5\mu$."
(Translated from the Japanese by N. Wakabayashi.)

(NOTE: According to Abe, "Cultures received from Kominami and Tubaki as *P. luteo-caerulea* Saito and Minoura, duplicated almost exactly the description of *P. herquei*" (given by Abe). Jour. Gen. Appl. Microbiol., Tokyo 2: 130. 1956.

Penicillium macedonense Verona and Mickovski, Mycopathologia 18: 292. 1962.

"On Czapek's agar with 3 percent glucose there is slow development of very sparse mycelium; the colony attains in fact 1.5 cm. in dm. after 2 weeks and about 4 cm. after a month.

"The colony appears granular, due to the formation, on the sparse mycelium, of numerous sclerotial bodies; slightly radial structures, margins not distinct, color at first white or slightly cream-colored, afterwards pale ochre and then darker ochre. No odor and no exudate. Reverse uncolored.

"On malt agar, growth and appearance of the colony is profoundly different. After two weeks the colony attains 3–4 cm. dm. and exhibits clipped mycelium, but denser, of dark color and dark-burnished. In the central part the appearance is nevertheless finely granulose and the color clear brown. Margins even, distinct, of brown color yet clearer. Radial furrows of gray-green are present.

"No odor or exudate. Reverse dark-burnished with a clearer or darker zone.

"Mycelium hyaline, regular, but with frequent anastomoses. Conidiophores thick, 2.7–3.7μ and about 30–75μ long, nonseptate, smooth-

walled, dark-colored. Sterigmata only in one series, elongated, cylindroid, 2.1×7.9–9.2μ, 4–5 in number, greatly crowded among themselves. Conidia round 2.6–3.2μ, smooth-walled, greenish-hyaline, producing long, thin chains to 260μ.

"The same hypha which bears the conidiophores (which itself comes either from a substrate hypha or from an aerial hypha) then causes the formation of variously organized chlamydosporous structures. Sometimes these consist of a short ramification of the hypha, bearing a catenulate series of chlamydospores. Other times such a ramification is longer, that is to say thinner, 18–42μ, and assumes the appearance of the conidiophore and itself ramifies into 3–5 divergent branches, similar to phial-shaped sterigmata about 2.7–3.4×5.3–7.9μ. Such a structure closely resembles that characteristic of *Scopulariopsis*. At the end of this branch it develops chains of 20 or more small, delicate chlamydospores. These are globose at once, with strongly spinulose or rough walls; they are dark-burnished and measure 4.7–5.4μ.

"The formation of hard and abundant sclerotia occurs especially on Czapek's agar. They are globose or ovoid, greatly delicate, to 170μ, ochre-yellow and clear in the young colony, a little darker in the old colony."

(Translated from the Italian.)

NOTE: Verona and Mickovski believe that this fungus should be considered a member of the Monoverticillata, although certain of its characteristics are similar to those of *Scopulariopsis*.

Penicillium madriti G. Smith, Trans. Brit. Mycol. Soc. 44: 44. 1961.

"On Czapek agar, grows fairly rapidly, pale blue-green, turning grey-green, with white edge about 2 mm. broad during the growing period, velvety but tending to become somewhat heaped in the centre; drops numerous, small, yellowish; reverse peach-coloured; indistinctly zoned; on malt agar grows very rapidly, greyish blue-green, thick velvety, with numerous yellow drops and reverse very reddish brown; penicilli with metulae each bearing a compact cluster of phialides, branching below the metulae not observed; conidiophores arising from the substrate, long, smooth, 2–3μ diam.; metulae slightly swollen at the apex, 10–11×2.5–3μ phialides tapering rather gradually, but not acuminate as in the Biverticillata, 7–8×1.5–1.8μ; conidia globose, finely roughened, 2–3μ, mostly 2–2.5μ diam., conidial chains forming a single fairly compact columnar mass, often bent or slightly twisted.

"This species appears to form a transition between the *P. citrinum* and *P. chrysogenum* series. In the lack of any branching below the metulae, it is nearest to *P. steckii* Zaleski, but the latter shows slower growth, thinner and more bluish colonies, and spore chains in several distinct columns, one to each metula.

"*P. madriti* was also grown in parallel cultures along with *P. cyaneofulvum* Dierckx, the member of the *P. chrysogenum* series which it most closely resembles. *P. cyaneofulvum* has thicker, almost floccose, colonies, penicilli which frequently show branching below the metulae, and much larger spores than *P. madriti*."

**Penicillium maltum* M. Hori and T. Yamamoto, Jap. Jour. Bact. 9: 1105. 1954.

"On Czapek's solution agar the surface of the colony is rough velvety at first, light gray-green in color, and the reverse is consistently dull brown. The growth of the mycelium is limited, the colony is radially furrowed, and is flat but the center is somewhat raised. After 14 days, it measures 3.0–3.5 cm. in dm. and is circular in outline. The colony border is white and is 0.5–1.0 mm. wide. The colony appears dry and hard.

"The conidiophores are solitary or are in fascicles for part of their lengths. At their apices, either alternatively or somewhat densely, the penicilli are branched but they all branch below the metulae in an asymmetric fashion. Overall, it is observed that the penicilli are fasciculate. Further, the penicillus is 400–500μ in length and is 3.0–4.0μ wide. The metulae are usually in groups of 2–4, they are short, 9.0–10.5 × 3.0–3.5μ. The sterigmata are also short and are densely clustered; their length doesn't exceed 4.5–6.5μ and their width is 2.5–3.0μ. The conidia are smooth and are ellipsoid to round, the long axis is 2.5–3.0μ. The conidia are poorly developed. The conidial chains are 35–50μ long.

"This fungus was isolated from a toxic milk cow feed ration and has been found to produce patulin."

(Translated from the Japanese by N. Wakabayashi.)

Penicillium marneffei Segretain, Capponi, and Sureau, Soc. Mycol. de France, Bul. 75: 416. 1958.

"On wort agar at a temperature of 27° C., three days after inoculation, the colony is flat, membranous, dull, finely folded and of a brownish-white shade; the reverse is uncolored. Eight days after inoculation, the diameter of the colony is 3.7 cm. At a portion of the thin, membranous margin, the culture is covered with a flat down, bluish gray-green at the center and white at the edge; the reverse and the agar are brick-red by diffusion of a pigment; this coloration can appear very rapidly, in 24–48 hours. The diffusion of pigment may tint the down rose in places.

"The lanose surface of the colony is formed from intermingled hyphae, septate, delicate, from 1–2μ in diameter. The sinuous conidiophores arise from aerial hyphae from which they are hardly distinct; they are smooth, septate, and their diameter is on the average from 1.5–2μ; their length is very variable, from 70–175μ, and the average is 111μ.

"The clearly divaricate penicillus is most often almost symmetrical, and merely a careful examination at high power, shows that the metulae never arise from the end of the conidiophore. The length of the penicillus is 20μ on the average, with a minimum of 12–15μ and a maximum of 40μ when branches are present, which is rarely. Sometimes, one of the metulae is much longer than the others and then is frequently septate.

"Metulae and sterigmata are of identical length: 9μ average, 7μ minimum, and 11μ maximum. The average width of 2.7μ of the metulae

is slightly larger than that of the sterigmata: 2.5μ. The metulae, which number 4 or often 5, are separated from each other, open angles existing between them. The sterigmata, arranged in verticils of 4 to 6 at the tips of the metulae, are acuminate; they are enlarged at their centers and thin down sharply to their tips to form the tube which produces the conidia.

"The conidial chains are never parallel and are never formed into columns. They are clearly distinct and tangled. In the chains, the smooth conidia are at first oval, bound together by a connective; they are next subglobose, often apiculate, and measure between 2 and 3μ in diameter and an average of 2.3μ. One may very rarely observe one or two conidia at the end of a chain, much larger than normal conidia: This is "Corda's phenomenon".

"The microscopic morphology is the same on malt agar. We have verified that the fructifications on Czapek's agar have the same characters as on wort agar, but they are in general more or less thicker.

"According to (the classification of) Raper and Thom, *P. marneffei* is not in the Biverticillata-Symmetrica section but is in the Asymmetrica-Divaricata. It has certain characteristics of *P. janthinellum* Biourge, a soil fungus, and of *P. citrintum* Thom, which is especially common in the Southwest Pacific. It can be distinguished however from the first species by its fuller penicillus (there are a larger number of metulae and phialides), by the absence of growth on Czapek's medium, and by the color of the diffusible pigment which is red or sometimes yellow but never purple; it is distinguished from the second species by good growth on wort agar, by a distinctly more open penicillus, by shorter metulae (7–11μ instead of 12–20μ), by conidial chains which have no tendency to form columns, and finally by the absence of antibiotic production."

(Translated from the French.)

NOTES: 1. The above description was taken from Mycopath. et Mycol. Appl. 11: 327–353. 1959.

2. This fungus was reported to be parasitic on *Rhizomys sinensis*, the bamboo rat.

Penicillium megasporum Orpurt and Fennell, Mycologia 47: 233. 1955.

"Colonies on Czapek's solution agar growing fairly rapidly, attaining a diameter of 4.0–4.5 cm in two weeks at room temperature, consisting of a thin, close-textured mycelium, forming an almost brittle felt; radially furrowed, central area often raised and bearing limited conidial structures, becoming olive-buff to deep olive (Ridgway, Pl. XLV); surrounded by a zone 2.0–3.0 mm wide, becoming dull greenish-black (R., Pl. XLVII) due to presence of abundant conidial structures shading into a white submarginal area; exudate lacking; odor not distinctive; reverse olive-ochre to yellow-olive at 10 days, near Prout's brown (R., Pl. XV) in age, with the pigment diffusing into the agar; conidiophores arising from the substrate or the aerial felt, septate, smooth, hyaline, 3.0–4.0μ in diameter and up to 300μ in

height; pencilli biverticillate, asymmetric, divaricate, variable in pattern but usually consisting of a verticil of 2–6 divaricate metulae; metulae mostly 4.0–5.0×10–12μ; sterigmata 3–5 per metula, divergent, bottle-shaped, 5.0–7.0×3.0–4.0μ; conidia in short, divergent chains, spherical averaging 6.5μ in diameter (5.0–7.0μ), thick-walled, dark olive-brown at maturity, coarsely echinulate, with dark-colored spines 1.0–1.5μ in length; prominent disjunctors 1.0–2.0μ long by 1.0–1.5μ wide.

"Colonies on steep agar essentially as above in rate of growth, texture, and colony pattern, but somewhat less regularly furrowed and slightly raised; conidial structures produced somewhat more abundantly with colonies more quickly assuming dull greenish-black shades and becoming olive-brown in age; exudate lacking; reverse and agar pigmented as on Czapek's; penicilli generally more regular in pattern.

"Colonies on malt extract agar growing more slowly, attaining a diameter of 3.5–4.0 cm. in 10 days, flat, unfurrowed, vegetative mycelium submerged, not forming a brittle felt, heavily sporulating, abundantly velvety but showing a thin surface network of aerial hyphae bearing scattered conidial structures, with thin marginal area white, shading rapidly through shades of American green to dull blackish-green (R., Pl. XL), finally becoming olivaceous black (R., Pl. XLVII); no exudate; reverse uncolored or nearly so; penicilli generally as described above but occasionally showing much more complex structures rebranched as many as five or six times below the level of the sterigmata, consistently producing the coarsely echinulate, spherical conidia characteristic of the species.

"*P. megasporum* can be best assigned to the *P. nigricans* series in the Asymmetrica-Divaricata section of the genus as considered by Raper and Thom (1949). It would seem to be more closely related to *P. melinii* Thom than to any other presently recognized species, although it differs from the latter species in certain striking characteristics. The globose, rough conidia of *P. megasporum* average about 6.5μ in diameter, whereas those of *P. melinii* measure 3.0–3.5μ; and the conidiophores of *P. megasporum* are smooth on all substrata while those of *P. melinii* are conspicuously granular-tuberculate."

**Penicillium meleagrinum* Biourge var. *viridiflavum* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 92. 1956.

"Colonies on Czapek agar grow rapidly, attaining a diameter of 41 to 53 mm. in 10 to 12 days at 25° C, consisting of a comparatively thin basal felt bearing crowded conidial structures; some strains velvety, and other strains lightly subfloccose; sometimes zonate, with central area often somewhat raised, in some strains smooth; with a white margin 1.0 to 1.5 mm. wide; conidial areas in gray blue green shades in marginal areas and dull yellow green shades in central or subcentral areas, becoming quickly near Andover Green, Vetiver Green throughout with age; exudate lacking or limited, colorless; odor limited, moldy; reverse in dull yellow to pale brownish shades, with surrounding agar usually uncolored; conidiophores arising primarily from the substratum or from the basal felt, variable in length,

commonly up to 120–320μ in length by 2.1–3.8μ in diameter, with walls smooth or nearly so, and with apices enlarged to 2.8–5.0μ in diameter; penicilli biverticillate and asymmetrical, commonly showing one or more branches in addition to the main axis, terminating in verticils of 2 to 5 metulae-bearing sterigmata; branches variable, commonly 9.3–31.0μ in length by 2.1–3.8μ in diameter; metulae usually 9.3–18.7μ by 2.1–3.8μ; sterigmata in fairly compact verticils of 4 to 8, mostly 8.1–10.0μ by 1.8–2.6μ, acute type; conidia elliptical to subglobose, mostly 2.1–3.0μ by 1.7–2.6μ, smooth walled or nearly so; conidial chains usually columns up to 60–190μ in length, and conidia show delicately roughened walls in electron microscopy. Colonies on steep agar grow rapidly, 54 to 68 mm. in 10 to 12 days at 25° C, smooth or slightly radically furrowed; some strains typically radically furrowed; conidial area quickly in olive brown or gray olive shades, reverse typically brownish shades; the other characters are as described above.

"These strains differ from *P. meleagrinum* Biourge primarily in the length (2.1 to 3.0μ) of conidia, in the colonies quickly becoming dull-green, in the longer metulae and branches, and because of their luxuriant growth on Sakaguchi and Wang agar.

"The strains also differ from *P. chrysogenum* Thom primarily in the pigments developed in the colony reverse and the size of conidia as described above."

NOTE: "*P. meleagrinum* Biourge var. *viridiflavum* Abe is *P. janthinellum*." G. Smith, Trans. Brit. Mycol. Soc. 46: 332. 1963.

Penicillium montanense Christensen and Backus, Mycologia 54: 574. 1962.

"Colony on malt agar 4.6–5.4 cm. in diam. in 14 days at room temperature; surface plane, floccose to felt-like, becoming velutinous with sporulation; margin irregular, periphery 3–4 mm, white; sporulating surface dark olive, becoming brownish black in age; reverse colorless, pale russet (especially in fresh isolates); no exudate; odor not distinctive.

"Colonies on potato-dextrose agar similar to those on malt agar but growth more luxuriant, with conidiophores typically forming a heavy, uniform, velutinous turf, spore mass becoming brownish black earlier than on malt extract agar.

"On Czapek's agar growth very poor; colonies 2.2–2.4 cm. in diam. in 14 days at room temperature; mycelial mass thin, largely submerged,, supporting uniform but sparse conidiophore production; conidia deep blackish green, becoming fuscous; reverse uncolored; exudate lacking; odor not distinctive.

"On cornmeal agar mycelial mass thin but spreading, mostly submerged or closely appressed to the surface of the substrate; conidiophores relatively sparse; conidia becoming brownish back almost as soon as formed, any green color being very inconspicuous and transitory.

"Conidiophores arising directly from the substrate and from low

aerial hyphae, up to ca. 550μ tall $\times$3–4.5μ in diam.; stalk uncolored, smooth; conidiophores simple, unbranched below the sterigmata, or less frequently with one to six widely-spaced divaricate branches, each ending in a monoverticillate penicillus; branches varying greatly in length, often 25–60$\times$3–4μ, occasionally rebranched; sterigmata somewhat divergent or nearly parallel, mostly 7–10$\times$3–4μ, commonly in verticils of 5–9 (but from 3 to 12) elements, on apices enlarged to 5–7μ across. Conidia in tangled chains or loose columns up to 160$\times$25μ, initially subglobose, becoming spherical, commonly 4–4.6μ but ranging from 3.5–5.4μ in diam., thick-walled, olive brown by transmitted light with conspicuous spines about 0.5–1.0μ long. Connectives sometimes conspicuous, especially in young spore chains.

"*Penicillium montanense* exhibits morphological and cultural features suggesting affinities with several previously described species. According to Professor Kenneth B. Raper . . . *P. montanense* resembles *Penicillium fuscum* (Sopp) Raper and Thom (*P. restrictum* Series, Section Monoverticillata) more closely than it does any other species included in 'A Manual of the Penicillia'. However, *P. montanense* differs from *P. fuscum* in a number of microscopic features, notably in its generally taller and coarser conidiophores and in the lack of pigmentation in its conidiophore walls. It also grows much more poorly on Czapek's agar. On the other hand, despite its predominantly monoverticillate habit, there is much to indicate a possible close alliance of *P. montanense* with members of the *P. nigricans* Series in the Asymmetrica-Divaricata. Especially the color of the conidia and the strong echinulation of the spores remind one of a number of taxa in that Series. *Penicillium megasporum* Orpurt and Fennell, a recently described member of the *P. nigricans* Series, although differing from *P. montanense* in having typically well-defined whorls of metulae (and substantially larger conidia), is strikingly similar in cultural features, in the morphology of its spores, and in the presence of conspicous disjunctors."

**Penicillium nigricans* Thom var. *sulfuratum* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 83. 1956.

"Colonies on Czapek agar grow rather rapidly, attaining a diameter of about 43 mm. in 10 to 12 days at 25° C, consisting of a comparatively deep basal felt bearing crowded conidial structures, subfloccose, with surface typically broadly radially furrowed, with a white margin 1.0 mm. wide, conidial areas in dark dull green near Dark Ivy Green, becoming Dark Grayish Olive with age; exudate lacking; odor strong, suggesting certain species of *Actinomyces;* reverse pale yellow, becoming pink, surrounding agar colorless, becoming pale pink; conidiophores arising primarily from the substratum or from the basal felt, occasionally from aerial hyphae, variable in length, commonly 60–250μ long by 2.5–3.1μ in diameter, with walls smooth or nearly so, with apices 3.1–4.4μ in diameter; penicilli biverticillate, asymmetrical and strongly divaricate, with branches and metulae varying markedly in arrangement and in size; branches variable, commonly 10.2–26.4μ by 2.5–3.3μ; metulae typically strongly divergent,

mostly 9.3–18.7μ by 2.5–3.4μ, in verticils of 2 to 4; sterigmata in somewhat divergent verticils of 5 to 8, mostly 6.2–8.7μ by 1.8–3.0μ, acute type; conidia typically globose to subglobose and walls typically aculeate, mostly 2.5–3.4μ; conidial chains loosely parallel or tangled, up to 30–90μ in length; and conidia showing typically aculeate walls in electron microcopy.

"Colonies on steep agar growing rather rapidly, about 45 mm. in 10 to 12 days at 25° C, conidial areas are typically Slate Olive becoming Dark Grayish Olive, and reverse becoming brownish; the other characters are as described above.

"This strain differs markedly from *P. nigricans* Thom, primarily in the rather rapidly spreading character of its growth, in the subfloccose colonies, and in the yellow color, becoming pink, of its reverse, in the metulae mostly 9.3–18.7μ in length, and in the typically aculeate walls of its conidia.

"The strain also differs markedly from *P. albidum*, *P. kapuscinskii*, *P. melinii*, and *P. raciborskii*, primarily in the typically smooth conidiophore walls, in the conspicuously aculeate walls of its conidia, and the typically olive conidial areas."

**Penicillium nopporoense* Sasaki and Nakane (as "*nopporoensum*"), Jour. Agr. Chem. Soc. Japan 19: 775. 1943.

"Grows well on Czapek's solution agar; after 5 days it measures 0.8 cm. in dm. It is barely pallid Quaker drab (Ridgway, Pl. LI) and loosely tomentose. The reverse is white at first, later it is white or primrose yellow (Ridgway, Pl. XXX), with large, loose wrinkles. The conidiophores measure 110–250μ×1.3–2.1μ and their surfaces are smooth and flat. They are branched and the branches measure 12–16×1.5μ. The sterigmata are 10–12×1.5–2.5μ, and their tips are sharp-pointed and they number 3–5 per metula. The conidia are spherical and measure 2.5–2.6μ; they are rough.

"This fungus is assigned to the Asymmetrica, Lanata-Divaricata; it resembles *P. lilacinum* but differs in the colony reverse which is primrose yellow, and in the spherical, rough conidia."
(Translated from the Japanese by N. Wakabayashi.)

Penicillium novae-caledoniae G. Smith, Trans. Brit. Mycol. Soc. 48: 273. 1965.

"Colonies on Czapek agar growing rapidly, bluish grey green at first, becoming greyer and duller, with narrow white margin during the growing period, thick velvety to matted floccose, with reverse at first buff to dull pink, becoming pinkish brown; penicilli usually with terminal verticil of metulae, these being commonly of different lengths in the same verticil, sometimes with a secondary branch from the next lower node of the conidiophore, typically divaricate; conidiophores rough, mostly 3μ diam.; metulae 10–15×3μ, often widening somewhat towards the summit; phialides short-pointed, 8–10×2.2–2.5μ; conidia

slightly rough, subglobose, 2.5–3μ diam.; conidial chains at first more or less parallel, soon becoming tangled.

"This species is probably to be classed in the Divaricata. The shape of the phialides (short-pointed) excludes it from the *P. janthinellum* series, and the tangled conidial chains and lack of deep red brown reverse color exclude it from the *P. canescens* series."

Penicillium ochrosalmoneum Udagawa, Jour. Agr. Sci. Tokyo Nogyo Daigaku 5: 10. 1959.

"Colonies on Czapek agar rather rapidly growing, velvety to sublanose, folded or wrinkled, consisting of a close-textured yellowish basal felt in which are embedded abundant sclerotia, medium to light sporing throughout, heavier in central areas, in grayish blue green shades from pistachio green to American green (Ridgway, 1912), odor pronounced, strongly earthy, reverse pale yellow, showing a brown tinge. Conidiophores 80–160 or more×2–3.2μ, arising primarily from the basal mycelial felt or as branches of aerial hyphae, smooth or nearly so. Penicilli variable in form, sometimes monoverticillate but mostly asymmetric, consisting of a terminal group of divergent branches or metulae borne at different levels. Branches, when present, 15–30×2.5–3μ. Metulae 2–4 in number, 8–16×2.5–3.2μ. Sterigmata 7–9.5×2–2.5μ, compact clusters of 6–10. Conidia subglobose to ellipsoid, or pear-shaped 2.5–3.2×1.5–2.5μ, with smooth walls; conidial chains short, tangled.

"On potato-dextrose agar, growing rapidly, plane, producing numerous sclerotia in a dense layer adjacent to the basal felt, enmeshed in and overgrown by loose yellow encrusted mycelium, penicilli limited in number except in the center, not affecting the overall colony appearance, odor as on Czapek, reverse and agar clear yellow. Sclerotia light ochraceous-salmon, subspherical to ovate, 250–300 (340)μ in long axis, hard.

"At 37° C., well growing, conidial structures lacking."

NOTE: D. B. Scott and Amelia C. Stolk reported in "Antonie van Leeuwenhoek" 33: 302, 1967, that this taxon has a perfect stage which they named *Eupenicillium ochrosalmoneum*. Their description of this stage is given as follows:

"Cleistothecia are spherical or subspherical, light ochraceus-salmon in colour, about 250–300μ in diameter. At first ascocarp initials develop into parenchymatous tissue, surrounded by loose wefts of radiating and twisted, yellow pigmented hyphae. It soon becomes sclerotioid and very hard, ripening slowly, commonly producing asci and ascospores within 4 to 6 weeks, sometimes longer than this and in some cases ascospores are never produced. At maturity the central areas of the ascocarps are filled with ascospores. Asci are borne singly as lateral branches from fertile hyphae, spherical to subspherical, 7–9μ in diameter and contain 8 spores. Ascospores are yellow, lenticular in shape, consisting of a spore body, measuring 3–3.5×2.2–3μ with walls slightly roughened and with two closely appressed equatorial

ridges about 0.5μ wide. The overall sizes of the ascospores are 3.7–4.2×2.5–3μ.

"The conidial form (i.e. *P. ochrosalmoneum*) obviously belongs in the sub-section Asymmetrica-Divaricata of *Penicillium*. On account of the structure of its penicilli and the long tapering phialides it is suggestive of the *P. janthinellium* series. The ascospores do not correspond to those of any other previously described form in *Eupenicillium*."

Penicillium odoratum Christensen and Backus, Mycologia 53:459. 1962.

"Colony on malt agar 2.2 to 5 cm in diameter in 14 days at room temperature. Margin commonly with well-developed stolon-like hyphae which give rise to peninsular ridges of conidiophores in advance of the colony mat; surface Artemisia green to lily green and deep slate green (Rdg. XLVII), plane, deep velvety; conidia in long columns; reverse uncolored to yellowish near sulphine yellow (Rdg. IV); no exudate; odor very strong, resembling the aroma of apples.

"Colony on Czapek's agar 3 to 7 cm in diameter in 14 days at room temperature. Marginal area thin, with coarse radiate hyphae growing both at the agar surface and submerged; these send lateral extensions downward, and give rise to short, erect conidiophores. Surface sporulating tardily; color, texture, and column development as on malt agar but conidiophores more widely spaced; reverse uncolored to light yellow-brown or gray brown near tilleul-buff or avellaneous (Rdg. XL), somewhat darker at colony center; exudate lacking or in small colorless drops; odor penetrating, fragrant.

"Conidiophores arising primarily from the stolon-like hyphae, 100 to 560μ long by 3–4μ in diameter, septate, coarsely roughened, uncolored, sometimes slightly sinuous, with well-developed lens-shaped vesicles commonly 7–9μ in broadest dimension but up to 10 by 6.5μ. Penicilli monoverticillate; sterigmata about 10 to 18 per vesicle, crowded, parallel, typically 9–12μ (6.5μ in one isolate) by 3–4μ. Chains of condia in columns up to 500μ long by 16–30μ, tangling in age and falling away en masse when the culture vessel is tapped; conidia elliptical at first, becoming ovate to subglobose, 3–4.1μ by 2.2–4μ commonly 3.5–4μ by 2.8–3.2μ, thick-walled, with roughening concentrated in transverse ridges so that the spores appear faintly banded.

"*Penicillium odoratum* resembles certain members of the *P. lividum* and *P. frequentans* series, but differs from all described species in the two series in colony color or texture, vesicle size, conidiophore length, shape and sculpturing of the conidia, or a combination of these features. Its closest relative probably is *P. trzebinskianum* Abe; the latter species, however, develops a darker colored reverse on both Czapek's and corn steep agar, has a vanilla-like odor instead of the apple-like odor that is characteristic of *P. odoratum*, has shorter conidiophores (60 to 280μ vs. up to 560μ), has somewhat smaller conidiophore apices, and is not described as having either conspicuous stolon-like hyphae or the resultant irregular colony margin."

**Penicillium oligosporum* Saito and Minoura, Jour. Ferment. Technol. 26: 5. 1948.

"This fungus grows rapidly on agar, it is white at first and turns yellow-green gradually; as the cleistothecia develop, the colony turns yellow-brown to brown. On wheat seedling juice agar, it forms a tight-surfaced clump and is white and tomentose. On malt, Czapek's, and potato agar, it appears brown with a red reverse because of the abundance of cleistothecia.

"The hyphae from newly-germinated spores are broad with a dm of 3–5μ. The cell walls are colorless, however from the sides of the main stem, numerous fine branches here and there gradually form broken clusters which enlarge and mature to form cleistothecia and inside many asci form. The cleistothecia are spherical or of no particular shape, yellow-brown to brown. The outside has a pseudo-soft system (?); the surface doesn't have special attached hyphae. Large numbers of cleistothecia tend to form in clusters and the space between them is filled with fine hyphae. The cleistothecia measure 86–258μ in size. The asci are small, elliptical, or somewhat spherical. They are flat and smooth, and measure 3.1 or 3.1 × 2.5μ.

"Conidiophores when present are very short, with apices not particularly large and only 2–4 sterigmata are borne on each one. However, at times conidiophores cannot be seen and the sterigmata then appear directly from the mycelium and form spores at their tips. Therefore, this fungus resembles a *Citromyces* type but generally is random shaped. The conidia are spherical, smooth, 2.5–3.5μ. Spores are borne in chains. This fungus was isolated from soil."
(Translated from the Japanese by N. Wakabayashi.)

NOTE: According to Abe, "a culture received from Kominami and Tubaki and from Minoura as *P. oligosporum* Saito and Minoura duplicated almost exactly the description of *P. janthinellum*" (as given by Abe). Jour. Gen. Appl. Microbiol., Tokyo 2: 77. 1956.

**Penicillium palitans* Westling var. *echinoconidium* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 111. 1956.

"Colonies on Czapek agar are rather rapidly spreading, attaining a diameter of 50 to 53 mm. in 10 to 12 days at 25° C, usually radially furrowed, and with surface appearing granular to definitely tufted, typically fasciculate, heavily sporulating throughout, with a white margin about 1.5 mm. wide; conidial areas in dark yellow green shades, near Dusky Yellow Green, becoming dark olive near Dusky Olive Green with age; exudate limited, colorless; odor, definitely moldy; reverse colorless or pale yellow, becoming pale brown, with surrounding agar usually colorless, becoming tardily pale yellow; conidiophores, usually arising directly from the substratum, commonly up to 120–320μ in length by 4.3–6.0μ in diameter, with typical granular walls, penicilli generally showing 1 or 2 branches in addition to the main axis, branches typically appear and often unequal in the same peni-

cillus, commonly ranging from 11.2–24.0μ by 3.4–5.0μ; bearing metulae in groups of 3 to 5, mostly 9.3–13.7μ or occasionally 18.7 by 2.8–4.7μ; sterigmata usually borne in loosely compact verticils of 4 to 8, mostly 10.0–11.9μ by 2.5–3.1μ, acute type; conidia globose to subglobose, mostly 3.1–4.3μ, with walls conspicuously echinulate or verruculose, conidial chains variable, tangled, loosely parallel or divergent, up to 60–120μ in length; conidia walls typically conspicuously echinulate or verruculose as shown in electron microscopy.

"Colonies on steep agar spread rather rapidly, 51 to 55 mm. in 10 to 12 days at 25° C; the other characters are as described above.

"These strains differ from *P. palitans* Westling and *P. cyclopium* Westling var. *echinulatum* Raper and Thom, primarily in the typical conspicuously echinulate or verruculose walls of the conidia and usually producing the typical dark yellow-green shades, near Dusky Yellowish Green.

Since *P. cyclopium* Westling var. *echinulatum* Raper and Thom usually produced elliptical conidia, the author considers it most satisfactory to call (this strain) *P. palitans* Westling var. *echinoconidium* Abe because of the globose to subglobose conidia with conspicuously echinulate or verruculose walls."

NOTE: "*P. palitans* Westling var. *echinoconidium* Abe is *P. cyclopium* Westl. var. *echinulatum* Raper and Thom," G. Smith, Trans. Brit. Mycol. Soc. 46: 332. 1963.

**Penicillium paraherquei* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 131. 1956.

"Colonies on Czapek agar are rather broad, attaining a diameter of 50 to 68 mm. in 10 to 12 days at 25° C., consisting of a comparatively thin basal felt bearing crowded conidial structures; typically velutinous, often with a yellow mycelium, with a yellow margin 1.5 to 2.0 mm. wide, smooth; conidial areas in dark yellow green shades near Dusky Olive Green or Dark Green in central area and Dusky Yellowish Green or Antique Green in marginal areas, becoming olive green; exudate lacking or abundant, colorless or pale yellow; odor lacking or limited, moldy; reverse in greenish shades, near Medal Bronze or Aniline Yellow in the central area and Citrine Yellow in the marginal areas, with surrounding agar colorless, becoming weakly yellow; conidiophores arising from the substratum or the basal felt, sometimes from aerial hyphae, variable in length, commonly up to 190–240μ in length by 3.1–4.7μ in diameter, with apices 4.0–5.6μ in diameter, typically granular walled; penicilli typically biverticillate and symmetrical, definitey inflated, usually consisting of a single verticil of 4 to 7 metulae, each terminating in verticils of 4 to 6 sterigmata, metulae mostly 9.3–15.6μ by 2.5–4.1μ, loosely compact or somewhat divergent; sterigmata loosely compact, mostly 8.1–10.6μ by 2.1–2.8μ, characteristically tapered or narrow; conidia elliptical, mostly 2.9–3.3μ by 1.8–2.5μ, with slightly rough walls; conidial chains tangled or loosely parallel, up to 30–90μ in length; and conidia showing delicately echinulate or verruculose walls in electron microscopy.

"Colonies on steep agar are restricted or rapidly spreading, 25 to 58 mm. in 10 to 12 days at 25° C., surface radially furrowed; the other characters are as described above.

"These strains differ markedly from *P. herquei* Bainier and Sartory primarily in the delicately echinulate or verruculose conidial walls, mostly 2.9–3.3μ in length, in the rather broadly spreading character of growth, and in the infrequent production of a suggestively divaricate arrangement of the metulae.

"The strains also differ from *P. olsoni* Bainier and Sartory in the diameter of their conidiophores which is less than 4.0μ. The correct placement of the species remains in doubt, but it appears to be most satisfactorily assignable to (the *P. herquei* series) in the Symmetrica."

NOTE: G. Smith (Trans. Brit. Mycol. Soc. 46: 335. 1963) provided a Latin diagnosis for this species, the complete name of which is now *P. paraherquei* Abe ex G. Smith.

**Penicillium parallelosporum* Sasaki, Jour. Fac. Agr. Hokkaido Univ. 49: 147. 1950.

"Colonies on Czapek's solution-agar spreading, tea green (Rdg., XLVII, 25) to storm gray (Rdg., LII. 35′′′′′), floccose, 1.6 to 2.2 mm. in depth; reverse pinkish buff or cinnamon-buff (Rdg., XXIX, 17′′), mineral gray (Rdg., XLVII, 25′′′′) at margin. Conidiophores 150–250μ long by about 2.5μ with apex enlarged to 6.5–7μ in diameter, walls distinct spinulose, unbranched, sterigmata 10–15 by 3–3.5μ, 7 to 9 in numbers, single; conidial chains parallel to 300–400μ long; conidia elliptic, smooth, 2.5–3.5 by 1.5–2.3μ; perithecia or sclerotia are not found.

"Growth on Koji extract-gelatin abundant, distinctly rugose, mineral gray (Rdg., XLVII, 25′′′); reverse Isabella color (Rdg., XXX, 19′′); gelatin liquefied slowly, changing to brownish.

"Growth on potato abundant, rugose felted; conidial area poor, colorless to olive buff (Rdg., XL, 21′′′), substratum uncolored.

"Milk slightly peptonized; litmus reduced slowly."

Penicillium pedemontanum Mosca and Fontana, Allionia 9: 40. 1963.

"In plates on Czapek's agar at ambient temperature, the culture grows fairly rapidly, attaining in 12 days 2.5 cm dm., and about 4 cm, in 20 days.

"It consists initially of a basal mycelium, yellow straw-colored, that passes immediately to yellow-sulfur; in the central part of the fungus colony, after 4–5 days, the first conidial fructifications of bluish-gray appear, while on the entire surface of the colony there are abundant, rough sclerotia of cream color or very clear lemon-color.

"At complete development, the conidial area, always in the center, and somewhat reduced, appearing of powdery aspect, and of grayish-blue color, while the sclerotia abundant all over the surface, assume a gray-hazel color.

"A comparatively premature exudate of hyaline drops forms beneath the colony and they increase with the aging of the colony.

"The reverse immediately underneath the colony passes from dirty yellowish-green to yellow-orange, the pigment diffusing in the agar with clearer shading.

"On malt agar, it develops somewhat slowly and reduced: The colony attains a diameter of 3 cm in 12 days, and does not increase further; it has a transparent appearance, lacking a thick basal mycelium as on Czapek's agar and is somewhat lacking in sclerotia and conidial fructifications.

"Reverse yellow lemon-colored, conidial area bluish-gray, sclerotia a yellow lemon-color to yellow-gold.

"Under the microscope the basal mycelium appears to consist of straw-colored hyphae, smooth-walled and of granular content, with septa hardly evident, measuring on the average 1.5–2μ rarely 3μ in diameter.

"The conidiophores, arising from the substrate, measure from 250–550μ (with a minimum of about 100μ and a maximum of 600) $\times$3–3.3μ; they are septate, have smooth walls, and are terminated generally by a single biverticillate penicillus.

"The metulae, 4–5 in number, measure from 8–11.2μ (average 9μ) $\times$3–3.2μ; each metula bears a verticil of 6–7, rarely 5, pseudosterigmata, length about 7.5μ and width from 1.9–2.2μ. These biverticillate penicilli are generally somewhat compact, with metulae of somewhat symmetrical arrangement; sometimes, however, the metulae assume the shape that is normally observed in the subsection Asymmetrica-Divaricata of Thom and Raper, they are namely more or less divaricate and not always of equal length in the penicillus. There are usually observed afterwards especially in young cultures, typically monoverticillate conidiophores and conidiophores terminating with two branches of diverse length (no longer considered to be metulae) each bearing a monoverticillate penicillus.

"The conidia, from oval to subglobose, have smooth walls and measure 2.4–2.8$\times$1.9–2.4μ.

"The sclerotia for the most part have an irregular shape, sometimes elliptical or sublobose, and of not very constant dimensions: At full development, on Czapek's agar, they measure 180–430$\times$110–250μ. They have remarkable firmness and resistance to crushing. Sections cut with a freezing microtome (sections about 15μ thick) appear under the microscope to consist of roundish pseudo-cells, pyriform or irregularly elliptical, with somewhat thick walls, from 1.2–1.9μ (avg. 1.5μ), with the lumen varying from 4.8–11.2μ (avg. 6.5–8μ).

"The macro and microscopic characteristics that we describe correspond quite well in our judgment to the ones given by Raper and Thom (1949) for the Asymmetrica section, subsection Divaricata, however we could advance some reservation relative to the assignment of our species to this group of *Penicillium:* the metulae of our fungus, for example, are not normally divaricate, but they form a rather compact penicillus such that it makes us think of the one found in the *P. citrinum* series (subsection Asymmetrica-Velutina) or sometimes it makes us think of the section Biverticillata-Symmetrica. The aspect of the

colony, notwithstanding, is not so finely velvety or powdery as the typical Velutina *Penicillium*, nor for that matter are the penicilli slender and the sterigmata pointed like the typical Symmetrica.

"For these reasons, by its general characteristics, we can place our single species in the other section of Raper and Thom (i.e. Asymmetrica) and we exclude it from the Biverticillata-Symmetrica section.

"In conclusion, the sporadic presence of divarticate penicilli, the sometimes varied length of the metulae of a given penicillus, the appearance of a young culture of monoverticillate form, the colony texture which is weakly granular, and finally, the formation of sclerotia, are seemingly sufficient characteristics to assign our *Penicillium* to the subsection Asymmetrica-Divaricata of Raper and Thom." (Translated from the Italian.)

Penicillium phialosporum Udagawa, Jour. Agr. Sci. Tokyo Nogyo Daigaku 5: 11. 1959.

"Colonies on Czapek agar growing restrictedly, velutinous to filamentous (delicately fibrous), umbonate in central areas, up to 2 mm. high, deep dull yellow-green to Danube green (Ridgway, 1912), showing little interlacement of sterile yellow hyphae with margins arachnoid, very thin, largely submerged, reverse greenish black tinged with pale yellow. Conidiophores varying in length, 100–200μ or more when arising from substratum, 20–80μ when arising as branches from aerial hyphae, 2.5–3.2μ in diam., smooth. Penicilli very irregular in pattern and dimension, mostly with asymmetrical or biverticillate structures (unequally arranged) that are often partly divaricate, sometimes monoverticillate on short stalks from trailing hyphae. Branches 15–40 or more $\times$2.5–3μ. Metulae 8–13$\times$2–2.5(3)μ, in groups of 2–5. Sterigmata abruptly pointed, 4–6 in the verticil, 10–16$\times$2–2.5μ, with terminal collarettes. Conidia (phialospores; see Hughes, 1953, and Tubaki, 1958) elliptical to subglobose, 3.2–4.5$\times$2–3μ, heavy-walled, smooth or nearly so, in tangled or loosely parallel chains up to 300μ in length.

"On malt agar, growing rather rapidly, velvety, plane, in dull green shades near bottle green, zonate, with margins entire, narrow, reverse uncolored.

"On potato-dextrose agar, similar to those on malt, but quickly becoming dark blue green to greenish black.

"At 37° C, poor growth."

Penicillium pidoplitschkanum Chalabuda, Not. Syst. Inst. Bot. Acad. Sci., U.S.S.R. 6: 161. 1950.

"Colonies on Czapek's agar of limited growth, tomentose, white for a long time at length brown; reverse white later milky-yellow. Colonies on sugar beet root extract agar often irregular more or less circular, tomentose, pubescent, hard base. Colonies initially white, later yellow, at length brown, not zonate, sterile margin not consistent, reverse dark brown. Hyphae light yellow, often distinctly septate,

15.44–345×2–3.5μ. Abundant penicilli, biseriate, asymmetric, dense, with 4–7 metulae, 8.5–12μ. Conidiophores flask-shaped, 8–14×2.8–3.5μ. Conidia lemon-shaped, very slightly roughened, on both sides hardly papillulate, 3.5–4.5×2.8–3.5μ, pale yellow in mass."
(Translated from Latin diagnosis.)

Penicillium pinetorum Christensen and Backus, Mycologia 53: 457. 1962.

"Colony on malt agar 4 to 5.1 cm in diameter in 10 days at room temperature. Surface velvety, andover green to slate-olive becoming dark ivy green in age (Rdg. XLVII); yellow to tan colored sclerotia abundant and characteristic in most isolates, sparse in others and often failing to develop after continued maintenance of an isolate on agar; sclerotia typically in sectors and in concentric bands which contrast with the deep green zones of sporulation; reverse uncolored; no exudate; no distinctive odor.

"Colony on Czapek's agar 1.3 to 2 cm in diameter in 10 days at room temperature. Colony thin, powdery, near deep olive (Rdg. XL) in color; sclerotia in sectors, often more abundant on this medium than on malt agar; reverse uncolored; no exudate; no distinctive odor.

"Conidiophores usually arising as short perpendicular branches from trailing hyphae, 10–88μ commonly 20–40μ by 2.5–4.3μ; stalk uncolored or faintly pigmented, delicately roughened, ending in an apical swelling 5μ or less in diameter. Penicilli mostly strictly monoverticillate; sterigmata nearly parallel in compact clusters, 5 to 9 per apex, commonly 8μ by 3μ but ranging from 7.5–13μ by 2–3.5μ, wall sometimes appearing delicately roughened. Conidia adhering in columns up to 290μ long in old cultures by 15–20μ broad; uniformly globose, smooth when young, but later with spines up to 1μ long, thick-walled, not banded, mostly 5–5.5μ in diameter at maturity. Sclerotia scattered and in small clusters, commonly involved in a loose network of uncolored hyphae; gritty; globose to subglobose, mostly 140–180μ but up to 330μ in diameter; Marguerite yellow darkening to honey yellow (Rdg.XXX) in age.

Penicillium pinetorum is assignable to the *Penicillium thomii* series on the basis that it is a monoverticillate form regularly producing gritty sclerotia. In our opinion, *P. thomii* Maire is probably its closest known relative. However, the latter species is easily distinguished by its longer conidiophores, its smooth-walled, often elliptical conidia and it sclerotia, which are usually pinkish orange."

Penicillium piscium (Plehn) amend. Reichenbach-Klinke (Syn. *Nephromyces piscium* Plehn), Bremerhaven Inst. f. Meeresf. Veröffentl. 4:115. 1956.

"Exogenous hyphae hyaline, septate, 2μ wide, with exogenous conidia (globose, 1.6–2μ dm.) borne on sterigmata.

"Endogenous hyphae hyaline, septate, 2–3μ wide.

"Ascogenous hyphae with ascospores (ovoid, mostly two-parted, 4–6 × 6–10μ dm., brown) and globose, thick-walled, brown chlamydospores (6–10μ dm.), pseudoparenchymatic network and support-hyphae; endogenous hyphae often with sclerotial cells. Asci decaying early, fruiting body and peridium mostly hardly developed. The sexual bodies appear extraordinarily reduced; one is not able to observe the fertilization process. (Parasitic on fresh water fishes.)" (Translated from the German.)

Penicillium proteolyticum Kamyschko, Not. Syst. Crypt. Inst. Bot. Acad. Sci., U.S.S.R. 14: 228. 1961.

"Slowly growing on Czapek's agar, 2–2.5 cm dm. after 12–14 days at room temperature, velvety, velvety-lanose or lightly tomentose, smooth, aerial hyphae warty. Vegetative mycelium often hyaline or sometimes cream-colored in age. Conidial areas after 6–8 days are at first blue or after 12 days they are greenish-gray (according to the scale of Bondarzevii), and also yellowish. Colony margin plainly limited, 2–3 mm wide, white when young, cream-colored in advanced age, colony reverse salmon-colored to opaque-purple, sometimes brownish. The same pigment more or less diffused in agar in a variegated culture.

"After 10–12 days, the colony reverse consists of radial folds. Odor and exudate lacking. Colony appearance v.t.w.i.

"Conidiophores arising from tangled tomentose mycelium, 100–200 × 2.5–3.5μ, smooth walled. Penicilli biverticillate, symmetrical most of the time, sometimes monoverticillate.

"Metulae 6–8 in diverging verticils, cylindrical, 9.5–14 × 3μ. Sterigmata top-shaped in diverging verticils, with tubuliform apices, 9.5–12 × 2.5μ. Conidia brown, lemon-shaped or elliptical or rarely round, 2–2.5 × 3μ, smooth walled or slightly roughened, diverging or in tangled chains, greenish-gray in mass.

"Growing slowly in corn extract agar, 2–2.5 cm in dm. after 12–14 days, velvety-wooly. Vegetative mycelium white. Part of the spores blue-green-gray or gray-green. No odor. No exudate or very tiny drops, hyaline or hardly cream-colored; colony reverse darker than the medium v.t.N_2. Conidiophores as on Czapek's medium.

"In wort agar colonies grow slowly, 2–3 cm in dm. after 12–14 days. Colonies velvety sometimes radially folded *pisacae*. Dark or dark-vinaceous color diffusing in the medium. Colony shape v.t.N_3. Conidiophores as on Czapek's medium.

"Colonies on Czapek's agar with NH_4NO_3 growing slowly, as on Czapek's medium with $NaNO_3$, more radially folded, reverse dark-rosy, the same color diffusing in the medium, conidiophores abundant." (Translated from Latin diagnosis.)

**Penicillium pseudocasei* Abe (as "*pseudo-casei*"), Jour. Gen. Appl. Microbiol., Tokyo 2: 102. 1956.

"Colonies on Czapek agar grow rather rapidly, attaining a diameter of 53 to 55 mm. in 10 to 12 days at 25° C, consisting of a compara-

tively hard basal felt bearing crowded conidial structures; typically velvety, with a white margin 0.5 to 1.2 mm. wide; strongly furrowed in a radial pattern; conidial areas in bright yellow green shades near Winter Green, becoming Dark Yellowish Green or Light Drab; exudate limited, colorless; odor limited, moldy; reverse in colorless or pale yellow shades; with surrounding agar colorless; conidiophores arising primarily from the substratum or from basal felt, variable in length, commonly up to 120–250μ in length by 3.1–4.7μ in diameter, with apices 3.7–5.6μ in diameter, and walls showing protuberances or larger granules; penicilli biverticillate and asymmetrical, commonly showing one or more branches in addition to the main axis, terminating in verticils of 3 to 5 metulae-bearing sterigmata; branches variable, commonly 15.6–34.0μ by 2.5–4.4μ; metulae usually 10.6–13.6μ by 2.5–4.1μ, loosely compact, with apices 3.1–4.6μ in diameter; sterigmata in fairly or loosely compact verticils of 3 to 6, mostly 10.6–13.1μ by 1.8–3.0μ, acute type; conidia typically elliptical to ovate, mostly 3.1–4.1μ by 3.0–3.4μ, with smooth walls or nearly so; conidial chains usually loosely columnar or tangled, up to 60–190μ in length; conidia showing smooth or nearly so walls in electron microscopy.

"Colonies on steep agar are rather broadly spreading, 60 to 64 mm. in 10 to 12 days at 25° C; the other characters are as described above.

"These strains differ markedly from *P. casei* Staub primarily in the typically elliptical conidia, the rather rapidly spreading growth, the colorless or pale-yellow reverse, the colorless surrounding agar, the conidia 3.1–4.1μ long, the sterigmata 10.6–13.6μ in length, the luxuriant growth on Sakaguchi and Wang agar, and the lack of an arachnoid margin.

"The correct placement of the species remains in doubt, but it appears to be most satisfactorily assignable to (the *P. roqueforti* series) in the Velutina subsection of the Asymmetrica as classified by Raper and Thom."

NOTE: G. Smith (Trans. Brit. Mycol. Soc. 46: 335. 1963.) provided a Latin diagnosis for this species, the complete name of which is now *P. pseudocasei* Abe ex G. Smith.

Penicillium radulatum G. Smith, Trans. Brit. Mycol. Soc. 40: 484. 1957.

"Colonies on Czapek agar spreading broadly, circular with regular margins, dark bluish green with narrow paler edge during the rapidly growing period, becoming very dark smoky blue-green, smooth velvety; respiration drops minute, yellow; reverse somewhat greenish yellow, with the colour diffusing throughout the agar; on malt agar or potato agar spreading fairly rapidly, 23–30 mm. in 9 days at 24° C, dark greyish blue-green with paler bluish margin, velvety; drops minute, yellow; reverse yellow to orange or reddish orange, with the colour diffusing slightly; penicilli markedly divaricate with the branches loosely divergent, usually with a terminal cluster of metulae and phialides mixed, and with a series of branches from lower nodes, bear-

ing metulae and phialides or phialides alone; conidiophores arising from the substrate, very rough, fairly long and 2.2–2.5μ diam.; rami and metulae often indistinguishable and very variable in length, rough; phialides rough, fairly abruptly pointed, 8–9$\times$2–2.4μ; conidia globose, spinulose, mostly 2.8–3.2μ diam. but occasionally up to 4.5μ, in chains which are usually divergent at first, becoming tangled, but are sometimes more or less parallel or even in loosely columnar masses.

"The fungus is to be classed in the Asymmetrica-Divaricata, and is closest to *P. melinii* Thom, which also has rough conidiophores and echinulate conidia. It differs from the latter in colony color and in the more constantly divaricate character of the penicillus."

Penicillium ramusculum Batista and Maia, Ann. Soc. Biol. Pernambuco 13(2) : 24. 1955.

"On 3 percent Czapek's agar the colonies develop in a limited manner, attaining a diameter of 2.5–2.8 cm after 10–12 days at temperature of 26–28°C., with a velvety mycelial texture, 2.3 mm thick, compact, irregular, not furrowed, azonate or inconspicuously zonate, raised in the central area, of bright olive-green color and with white margins, 3–4 mm wide, weakly sporulating; odor absent, exudate comparatively abundant, hyaline or citrine, reverse uncolored or yellow. Conidiphores ascending, arising from the substrate or as branches of aerial hyphae, that are arranged in a strongly interlaced network, smooth-walled, septate, hyaline, 15–25$\times$1.2–2.5μ. Penicilli monoverticillate, formed at the free end of the branches, of regular appearance, and consisting of clusters of 3–5 flask-shaped sterigmata, parallel or divergent, 5.6–7.8$\times$0.5–2.2μ. Conidia pyriform or cylindrical, hyaline or green, smooth, 2.2–2.8$\times$1–1.6μ, forming short chains, in compact columns of 8–10μ dm and 20–35μ in length.

"On malt agar the colonies develop a little more extensively, 2.5–3.6 cm dm, after 10–12 days at 26–28°C, the texture is also velvety, yet less compact than on Czapek's agar, with some tufts of aerial hyphae in central and median areas; quite zonate, ash-green colored in the center with white margins, 6–10 mm wide; odor absent; exudate absent; reverse cream. Conidiophores and penicilli as on Czapek's agar. Conida pyriform or cylindrical, yellow-green, smooth, 2.5–3.1$\times$2.2–2.5μ in compact columns, from 50–65$\times$12.5–15μ.

"On corn steep agar the colonies attain 2–2.5 cm in diameter, after 10–12 days and at 26–28°C they appear velvety, compact, raised in the central area, olive-green, umbonate, margins white, zonate, 10–12 mm wide with hyaline or citrine exudate; odor absent; reverse yellow. Conidiophores formed in the manner of ascending branches, on aerial hyphae, smooth, septate, hyaline, 10–60$\times$1.2–2μ. Penicillus typically monoverticillate with 3–4 sterigmata, flask-shaped, 5–7.5$\times$1.2–2.5μ. Conidia subglobose to pyriform, yellow-green, smooth, 2.5–3.1$\times$2–2.5μ in compact columns that approach as much as 100μ in length by 9–12μ in diameter."

(Translated from the Portuguese.)

Penicillium raperi G. Smith, Trans. Brit. Mycol. Soc. 40: 486. 1957.

"On Czapek agar grows restrictedly, 22–25 mm. in 9–10 days, and thereafter spreading only slightly, matted floccose about 1 mm. thick, at first pale yellow becoming mauve in patches, tardily turning pale bluish green all over or almost all over, with drops small, colourless, and reverse dull brown with intense yellow edge, but with no diffusion of the pigment into the agar, sporing tardily first in the mauve areas, more freely when the greenish colour appears; on malt agar grows rather more quickly, 30 mm. in 9 days and 42–45 mm. in 15 days, pale yellow and whitish with only traces of pink or mauve and turning greenish only very slowly and incompletely, with reverse deep dull yellowish brown; on potato-dextrose agar grows rather more quickly than on Czapek, much as on malt agar, yellow at first than with mauve centre but with a middle zone of pale bluish green, with reverse at first brown with yellow margin, then with centre purple and margin zoned with brown and deep greenish yellow; penicilli monoverticillate or, more often, irregular, with two to three unequal metulae, or with various superimposed verticils consisting of both metulae and phialides, but with the number of elements at each stage very small; conidiophores arising from aerial hyphae, very short, mostly less than 25μ long and 1.3–1.5μ diam; phialides few in the verticil, usually divergent, 7–9$\times$1.8–2.2μ, narrowed at the base and with fairly long tip; conidia irregularly ovate, slightly rough, 3–3.5$\times$2.4–2.8μ, many appearing to be globose or subglobose, but these are probably ovate conidia seen end-on; conidial chains short, divergent or tangled; numerous sterile branches produced from aerial hyphae, sometimes short and spur-like, sometimes longer, more or less club-shaped and frequently nodulose at the tip, resembling abortive conidiophores.

"*P. raperi* . . . is more nearly related to the *P. restrictum* series (than to the *P. lividum* series), which is characterized by floccose, not appreciably funiculose, colonies, with conidiophores 'arising primarily from aerial hyphae', and also by the production of spur-like sterile branches. However, the fact that a large proportion of the penicilli are not strictly monoverticillate, but consist of irregular verticils of phialides and metulae, suggests affinity with the *P. janthinellum* series."

Penicillium resedanum McLennan and Ducker apud McLennan, Ducker, and Thrower, Austral. Jour. Bot. 2: 360. 1954.

"Colonies upon malt extract agar spreading broadly 5–6 cm. in 14 days at 24° C. with mycelium forming a dense felt. The upper surface is very funiculose, and the overall colour is mignonette green (XXXI) fading towards the edge of the colony to lemon yellow (IV), with a tendency to zonation of colour. The margin of the colony is regular, thin, and white. The reverse of the colony is flat, pale, cream-coloured (XVI) with a buff centre.

"Colonies on Czapek's agar grow more restrictedly than on malt, attaining a diameter of 2.5 cm. in 14 days at 24° C. The funiculose

character is more pronounced than on malt; the colonies resemble little nests, the brim formed by a creamy-white lanose growing margin which surrounds the sunken mignonette-green centre. The reverse is cream to avellaneous in the older areas.

"Colonies on Raulin's agar grow more rapidly than on Czapek's agar, 4.5 cm. in 14 days at 24° C. The nest-like character is more pronounced with a small coloured sunken centre (Kronberg's green XXXI) surrounded by a very lanose white area, 1.5 cm. broad, with an abrupt margin. The reverse is slightly buckled, the centre antimony yellow, darkening to yellow ochre in age.

"Morphology as on malt agar—The colony is characterized by a profuse development of ropes 10–15μ wide, consisting of coloured hyphae from which numerous smooth conidiophores arise, 50–150μ long. Each conidiophore is sparsely septated uniformly 2μ broad, the apex is slightly swollen and bears a few (3–9) sterigmata; the spore chains are twisted into short columns. The sterigmata which are strongly tapered at their apices are 9–12 by 3μ. The conidial chains break up readily, the conidia are smooth and tinted, broadly elliptical, 2–3 by 1.5–2μ."

**Penicillium roqueforti.* Thom var. *punctatum* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2:99. 1956.

"Colonies on Czapek agar grow rather broadly, attaining a diameter of 58 to 62 mm. in 10 to 12 days at 25° C.; comparatively heavy sporulating; velutinous, with surface fairly smooth or slightly radially furrowed in marginal areas, with a white margin about 1.2 mm. wide; conidial areas in yellow green shades, near Deep Dull Yellow Green becoming Citrine Drab with age; exudate abundant, colorless; odor not characteristic or pronounced, slightly sour or moldy; reverse colorless becoming pale pink, near avellaneous throughout, with surrounding agar colorless; conidiophores arising primarily from the substratum or from basal felt, variable in length, commonly up to 120–380μ in length by 4.3 to 5.3μ in diameter, with apices 4.3–5.6μ long, with walls typically punctate or small-granular; penicilli biverticillate and asymmetrical, commonly showing one or more branches in addition to the main axis, terminating in verticils of 2 to 5 metulae-bearing sterigmata; branches variable, commonly 12.5–31.0μ in length by 3.1–4.7μ in diameter, with punctate or small granular walls; metulae usually 12.5–18.7μ by 3.1–4.5μ, loosely compact or somewhat divergent, with smooth or punctate walls; sterigmata in loosely compact verticils of 3 to 6, mostly 10.6–14.3μ by 2.5–3.6μ, acute type; conidia globose to subglobose, mostly 2.5–4.3μ, delicately echinulate or verruculose walls; conidial chains usually tangled or somewhat divergent, up to 60–190μ in length; conidial walls delicately echinulate or verruculose as seen in electron microscopy.

"Colonies on steep agar grow rather broadly, 58 to 67 mm. in 10 to 12 days at 25° C.; velutinous, with surface typically furrowed; conidial areas in bright yellow green shades becoming yellowish olive; reverse brownish shades; the other characters are as described above.

"These strains differ from *P. roqueforti* Thom primarily in the delicately echinulate or verruculose walls of the conidia, in the punctate or small granular walls of conidiophores and branches and metulae, in the pigmentation of the reverse, and also in not producing an arachnoid margin."

NOTE: "*P. roqueforti* Thom var. *punctatum* Abe is quite different from *P. roqueforti*; close to, and probably should be considered as *P. olivinoviride* Biourge," G. Smith, Trans. Brit. Mycol. Soc. 46: 332. 1963.

Penicillium rubicundum J. H. Miller, Giddens, and Foster, Mycologia 49: 797. 1957.

"Colonies on Czapek's agar at first white, later strawberry pink, Ridgway Pl. I, 2–4 cm in diam. at 10 days at 25° C, floccose, broadly zonate; reverse bitter-sweet to burnt sienna, Ridgway Pl. 2; conidiophores arise chiefly from aerial hyphae as short branches, or occasionally from substrate mycelium, 32–80×1.5μ; penicilli biverticillate or sometimes asymmetrical with branches or metulae arising at different levels, all elements smooth, metulae 4–5, slender, 6–7×1.5–2μ; sterigmata parallel-appressed, 7–9×2μ with attenuate apices, conidia globose to subglobose, 2–2.5×1.5–2μ, in tangled chains.

"According to Raper and Thom, this species would be placed in the Biverticillata-Symmetrica and in the *P. herquei* series, but it differs from all species in that series in the very small spores and very slender elements of the penicilli. Should it be considered asymmetrical, it would be placed near *P. aurantio-candidum* Dierckx. It differs from that species also in the same characters."

Penecillium sclerotigenum Yamamoto, Sci. Rpt. Hyogo Univ. Agr., Agr. Biol. Ser. 2: 69. 1955.

"Colonies on Czapek's agar fairly rapidly growing, mycelium slender, dense, crowded, compound, and sclerotia produced abundantly, radiately furrowed, central area more or less elevated, copper-colored, then ash-colored, becoming olive, surrounded by a submarginal zone 2–3 mm wide which appears white; exudate lacking, odor not distinctive; reverse orange-brown, pigment diffused in the medium; conidiophores loose or in dense tufts, arising from descending aerial mycelium, septate, smooth, hyaline, 78–292μ long, 3–4.5μ wide; penicilli bi- or triverticillate, asymmetric, for the most part consisting of 2–5 whorls of divergent metulae; metulae for the post part 9–16μ long; 2.5–4μ wide; sterigmata 1–6 on each metula, divergent, flask-shaped, 8–12μ long, 2.5–3.5μ wide; conidia in chains, elliptical, pale yellow-green, smooth, 4–6μ long, 3–4μ wide; sclerotia in dense clusters, globose up to ellipsoid, from brown to dark-brown, somewhat rough, 170–380μ long, 160–320μ wide."
(Translated from Latin diagnosis.)

Penicillium silvaticum Suprun (not "*P. silvaticum* Oudemans, 1902"), Bul. Soc. Nat. Moscow, Biol. 61(4) : 90. 1956.

"Colonies on Czapek's agar growing restrictedly, marginal zone flat, elevated in central area, furrows radiate and bent. Colony center granular consisting of sclerotia. Sclerotia smooth, at first sulfur yellow, in age dark-cinnamon, ovoid, 115–140μ×150–170μ. Colony edge becoming translucent. No exudate. Colony odor strongly moldy. Reverse ash-colored, center dark, with traces of bright sclerotia, after 14 days pale brick-colored. In the marginal zone of the colony, part of the fructifications are found to be colored dark-green. Conidiophores smooth 10–22×2–2.2μ, sometimes arising from aerial hyphae consisting of ropes. Penicilli monoverticillate. Sterigmata slender, short, inflated 6–6.5×3–3.5μ, divergent. Conidia spherical, echinulate, 3.8–4μ when young, 4.8–5.5μ when older, spines 0.5μ long."
(Translated from Latin diagnosis.)

**Penicillium spinulo-ramigenum* Sasaki, Jour. Fac. Agr. Hokkaido Univ. 49: 153. 1950.

"Colonies on Czapek's solution-agar spreading, raised at center to 2.1 to 2.2 mm. high, margin broadly submerged, velvety at marginal area, funiculose at central area, azonate, slate-olive (Rdg., XLVII, 29″″), later covered with white aerial hyphae; reverse center cream buff or honey yellow (Rdg., XXX, 19″), margin olive-gray (Rdg., LI,23″″). Conidiophores arising from submerged hyphae or branches of aerial or ropy hyphae, simple or branching with the secondary branches, each terminating in a monoverticillate penicillus, walls distinctly spinulose, 90–350μ long by 2.5–4.5μ in diameter, at apex enlarged to 5–6μ in diameter; sterigmata 10–12 by 3–4μ, 8 to 9 in number; conida globose or subglobose, 2.2 to 3.5μ in diameter, faintly roughened; conidial chains parallel; sclerotia or perithecia not found.

"Growth on Koji extract-gelatin abundant, andover green (Rdg., XLVII, 25″″), covered with white aerial hyphae; reverse light brownish olive (Rdg., XXX, 19″) to vandyke brown (Rdg., XXVIII, 11″) at center, Victoria lake (Rdg., I, 1) to black at margin; gelatin liquefied and colored to brownish red.

"Growth on potato abundant, raised and rugose, felted, Kronberg's green (Rdg., XXXI, 25″).

"Milk alkaline and peptonized at first, then changed to neutral; litmus reduced in 20 days."

Penicillium taxi Schneider, Zentbl. Bakt. II, 110, p. 47. 1956.

"Conidiophores arising from the substrate or aerial hyphae, septate, smooth, brown, not branching, or rarely with lateral branches; up to 900μ high, 4–5μ dm., tips inflated to 7μ, penicilli monoverticillate; sterigmata 5–9, for the most part 7, smooth, parallel, for the most part

17–18×5–5.5 (14–23×4–6.5)μ, conidia in very long divergent chains (up to 300μ), ellipsoid or subglobose, hyaline, for the most part 7–8×4μ (4.3–12.5×2.8–7)μ, smooth or very slightly roughened; sclerotia numerous in leaves of *Taxus baccata* fallen on the ground, in culture in all common substrates, none on Czapek's agar, 300–600μ long, globose, very hard, sclerotia heaped up, almost black.

"Colonies on Czapek's agar restricted but on malt growing broadly, after seven days attaining 5–6 cm; marginal area white formed by sterile hyphae 1 cm wide; sclerotia dark-olivaceous to brownish-black, numerous in concentric circles; conidial fructifications olivaceous-green, velvety, reverse in central area dark-olivaceous to dark brown; exudate translucent, for the most part abundant, odor not distinct."

(Translated from Latin diagnosis.)

"*Penicillium taxi* is, on the basis of its morphological properties, associated with the *P. thomii* series of the Monoverticillata section. It itself differs so from the known species in a succession of characteristics, and is especially striking because of its considerably larger sterigmata and conidia."

(Translated from a portion of the German text.)

**Penicillium thomii* Maire var. *flavescens* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 51. 1956.

"Colonies on Czapek agar grow broadly, attaining a diameter of about 80 mm. in 10 to 12 days at 25° C; smooth or plane; in bright yellow green shades near Empire Green or Danube Green, with a margin 1.0 to 2.0 mm, wide; sclerotia produced abundantly, hard, oblong to rounded, 190–510μ by 150–410μ, in shades near Pinkish Cinnamon or Salmon Orange, embedded in envelopes of colorless sterile encrusted hyphae, and crushing with difficulty; composed of very thick-walled polygonal cells, mostly 8–15μ in diameter, localized in the central area for 10 to 12 days, then scattered throughout the colony area; exudate abundant or limited, pale yellow shades; reverse and surrounding agar in pale yellow shades; conidiophores arising from the substratum or basal felt, sometimes from aerial mycelium, mostly 90–300μ long by 2.1–3.4μ in diameter, with apices enlarged, up to 3.7–6.2μ in diameter, with walls delicately granular; penicilli strictly monoverticillate; sterigmata in verticils of 8 to 14, parallel, mostly 9.3–10.6μ by 1.7–2.5μ, acute type with conidium-bearing tips somewhat narrowed; conidia elliptical or rarely subglobose, mostly 2.8–3.6μ by 1.7–2.1μ, with walls smooth or nearly so; chains of conidia in loose columns up to 60–160μ in length; conidia with delicately roughened walls (protuberances less than 0.1μ) in electron microscopy.

"Colonies on steep agar rather broad, about 63 mm. in 10 to 12 days at 25° C, loosely furrowed, turning to near Dusky Olive Green shades; reverse strongly yellow; other characteristics as described above for Czapek agar.

"This strain differs markedly from *P. thomii* Maire in the broad character of its growth, in the yellow-green color of its colonies, and also in the production of usually elliptical sclerotia (about 500μ in length), embedded in masses of white hyphae."

NOTE: "*P. thomii* Maire var. *flavescens* Abe, not distinct from *P. thomii*, varietal name superfluous." G. Smith, Trans. Brit. Mycol. Soc. 46: 332. 1963.

**Penicillium toxicarium* Miyake apud Miyake, Naito, and Sumida, Rpt. Res. Inst. Rice Impr. 1: 1. 1940.

"Mycelial growth of this fungus is limited and radial; its diameter after 14 days is 2.5–3.0 cm. The center is raised and somewhat irregularly mounded but the rest of the colony surface is smooth and flat. The raised portions are cracked and floccose. The colony edges are 0.5–1.0 mm wide; the obverse of the colony as well as the reverse are yellow. Conidiophores are 100–200μ×3.0–3.5μ; the penicillus is strictly monoverticillate; the sterigmata measure 7.5–8.0μ×3.0–3.5μ and are gathered in dense clusters at the tips of the conidiophores. The conidia are 2.0–2.5μ, somewhat spherical, and are borne in chains which are 25–50μ long."
(Translated from the Japanese by N. Wakabayashi.)

NOTE: 1. The above description was taken from the Jap. Jour. Bact. 9: 1105. 1954.

2. According to Abe, "*P. toxicarium* Miyake is assigned to *P. citreoviride* Biourge because of its globose conidia measuring 1.2–2.2μ, with walls smooth or nearly so, and its delicately rough walled conidia, measuring less than 0.1μ in electron microscopy." Jour. Gen. Appl. Microbiol., Tokyo 2: 57. 1956.

**Penicillium trzebinskianum* Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 63. 1956.

"Colonies on Czapek agar attain a diameter of 42 to 48 mm. in 10 to 12 days at 25° C., growing fairly rapidly, consisting of a somewhat compact basal felt, appearing velutinous or subfloccose, with a white margin 1.0 to 1.2 mm. wide, smooth or loosely radially furrowed, sporulating abundantly in darkish blue-green shades near Dusky Dull Green and in some, Dull Blackish Green in central areas; exudate lacking; odor definitely vanilla-like; reverse in yellowish green or vinaceous shades becoming olivaceous black, with surrounding agar in yellowish shades; conidiophores generally arising in a close stand directly from the substratum or basal felt, sometimes from aerial mycelium, mostly 60–280μ long by 2.5–4.0μ in diameter, with apices up to 3.7–6.9 or 7.5μ in diameter, with walls punctate or small granular, sometimes septated; penicilli strictly monoverticillate; sterigmata in verticils of 5 to 12, compact mostly 8.7–12.5μ by 2.1–3.2μ, acute type, with conidium-bearing tips sometimes narrowed; conidia elliptical to ovate or sometimes subglobose, mostly 2.5–3.8μ by 2.3–3.1μ, with walls echinulate and echinulate or verruculose walls observed in electron microscopy; chains of conidia in parallel or loose columns up to 30–190μ in length. Colonies on steep agar spreading, up to 43 to 54 mm. in

10 to 12 days, strongly radially furrowed, reverse near Umber shades becoming blackish brown, other characters as described above.

"These strains differ from *P. fellutanum* Biourge in the rapidly spreading character of their growth, the conspicuously roughened walls of their conidia, and the punctate walls of their conidiophores; they differ from *P. spinulosum* Thom in having elliptical conidia with conspicuously roughened walls.

"Moreover, these strains are separated from *P. trzebinskii* Zaleski by the abundant production of a vanilla-like odor, by the darkish blue-green shades of the conidial area, and by the rapidly spreading character of growth."

**Penicillium trzebinskii* Zaleski var. *magnum* Sakaguchi and Abe apud Abe, Jour. Gen. Appl. Microbiol., Tokyo 2: 62. 1956.

"Colonies on Czapek agar attain a diameter of 60 mm. in 10 to 12 days at 25° C, consisting of a sparse basal felt with thin aerial growth, appearing subfloccose but velutinous; seldom wrinkled and furrowed, and smooth or plane; conidial area sparsely sporulating throughout, in Stone Green becoming Light Yellowish Olive in age; exudate lacking; odor lacking; reverse usually colorless, turning to Drab shades, and surrounding agar seldom pigmented; conidiophores limited, commonly arising from submerged hyphae, sometimes from the aerial mycelium or the basal felt, variable in length, up to 170–440μ and 2.0–3.8μ in diameter, mostly unbranched, with the larger apices up to 3.7–5.0μ in diameter with walls punctate or small granular; penicilli strictly monoverticillate; sterigmata in verticils of 5 to 8; about 14.0–18.0μ by 2.1–3.7μ, compact or loose, acute type with conidium-bearing tips definitely narrowed; conidia long elliptical to ovate, mostly 3.3–4.7μ by 2.6–3.6μ, with echinulate or granular walls seen in electron microscopy; and chains of conidia in loose columns or loosely parallel, up to 60–180μ long.

"Colonies on steep agar grow more rapidly, up to 70 mm. in 10 to 12 days at 25° C, but the other characters are as described above.

"This strain differs from *P. purpurrescens* and *P. spinulosum* in its elliptical conidia with conspicuously rough walls. It is suggestive of *P. trzebinskii* Zaleski in the rapidly spreading character of its growth, the typically elliptical conidia with conspicuously rough walls, and also the rather long conidiophores with punctate or small granular walls.

"The strain also differs markedly from the descriptions given by Zaleski, Thom, and Raper and Thom, for *P. trzebinskii*, in the usual production of long elliptical conidia (3.3–4.7μ in long axis), in the yellowish shades of its conidia-producing area, in its long sterigmata, and in the usual production of sparse colonies."

NOTE: "*P. trzebinskii* Zaleski var. *magnum* Abe becomes P. *abeanum* G. Smith," Trans. Brit. Mycol. Soc. 46:332. 1963.

Penicillium ucrainicum Panasenko, Mycologia 56: 59. 1964.

"Colonies on Czapek's and malt agar sulfur-colored, from yellow aerial mycelium, not very subfloccose, reverse yellow-green. Cleistocarps abundant, globose or subglobose, yellow, 120–250 (400) μ in dm, loose textured, asci globose or subglobose, at first catenulate, six-spored, 6–7.5 × 6–6.8μ. Ascospores hyaline, ovoid, 2.5–3.5 × 2–2.5μ, equipped with two soft crests. Conidial fructifications small. Conidiophores short, 20–100 × 3–3.5μ, smooth. Penicilli monoverticillate or biverticillate, symmetrical; metulae 14–17 × 3–3.5μ, sterigmata 12–17 × 2.5–3μ. Conidia ovoid, 2.5–4.8 × 2.5–3.5μ, smooth, yellow-green in mass."
(Translated from Latin diagnosis.)

"From *P. vermiculatum* Dangeard and related ascogenous species it differs by the structure and dimensions of the conidial apparatus, by the structure of the cleistocarps, and by the 6-spored asci and ornamentation of the ascospores."

**Penicillium velutinum* T. Terui and K. Shibazaki (not *P. velutinum* van Beyma 1935), Jour. Ferment. Technol. 26: 257. 1948.

"On Czapek's agar at 30° C in dishes this fungus forms perfectly round colonies of green color in 2–3 days. The mycelium is velvety and becomes ashey-blue-green in zones as it ages. The surface is mostly flat and the edges of the colony are 1–2 mm wide and are white. The colony is quite dense; the reverse is yellow then red-brown. The exudate is colorless at first then yellow and gradually becomes peach-colored to brownish-yellow. The culture base color changes about the same way. There is no special odor and no sclerotia are observed.

"Penicilli are of two types, monoverticillate and asymmetric; the latter are more abundant. The conidiophores measure 200–300μ × 2.5–3μ and are smooth and rarely branched. Near its tip the conidiophore enlarges to 3.5–4.5μ. The sterigmata are borne in groups of 3 (rarely 2 or 4) and are attached directly to the conidiophore, or are found 2 (rarely 3) per metula. Metulae sizes are not the same but the ones with a length of about 15μ are most abundant. They usually have a width of 2.5–3.0μ at their bases and 3–4.5μ at their tips. The sterigmata measure 8–12μ (their middles are wider, to 2.4–3.2, than their ends) and taper at both ends but they do not come to a sharp point. The atypical sterigmata are of different shape and mostly asymmetrical and only if a verticil is somewhat enlarged to occasionally 20μ. Also sometimes one side of the metula will have only 1 sterigma and sometimes this sterigma becomes a secondary metula and bears secondary sterigmata.

"The mature spores are spherical, smooth, and faint ash-green in color. They have a dm of 2.7–3.0μ and are easily deformed by outside force.

"This fungus produces citrinin and was isolated from the air. It has penicilli that are characteristic of the Monoverticillata-velutina and the Asymmetrica-velutina. It most closely resembles *P. frequentans* but it has a much more asymmetric form, the number of sterigmata is small (i.e. 2), and the conidiophores are rarely branched."
(Translated from the Japanese by N. Wakabavashi.)

**Penicillium viridicyclopium* Abe (as "viridi-cyclopium"), Jour. Gen. Appl. Microbiol., Tokyo 2: 107. 1956.

"Colonies on Czapek agar grow rather rapidly, attaining a diameter 30 to 47 mm. in 10 to 12 days at 25° C, with surface smooth or in some strains loosely furrowed; with a white margin 0.8 to 1.5 mm. wide; typically or slightly fasciculate, abundantly sporulating throughout in most strains; conidial areas in typical yellow-green or bluish yellow green colors, in some strains, typical blue green; with surrounding agar usually quickly developing cinnamon or pinkish cinnamon shades, becoming orange cinnamon or brownish, broadly; exudate limited, colorless or pale yellow; odor abundant, moldy; conidiophores primarily arising from the substratum, commonly up to 120 to 380 or 440μ in length by 3.7–5.6μ in diameter, apices 4.0–5.8μ in diameter, with typical granular walls; penicilli biverticillate and asymmetrical, commonly showing one or more branches in addition to the main axis, terminating in verticils of 2 to 5 metulae-bearing sterigmata; branches variable, commonly 9.3–31.0μ or 37.0μ in length by 3.0–4.9μ in diameter, with granular walls; metulae usually 7.5–15.6μ by 2.5–4.5μ, with smooth walls or nearly so; sterigmata in fairly compact or loosely compact verticils of 3 to 7, mostly 8.1–12.5μ by 2.1–3.1μ, acute type; conidia globose to subglobose, mostly 2.5–3.8μ, smooth walled or nearly so; conidial chains loosely parallel or tangled, up to 50–220 or 260μ in length.

"Colonies on steep agar grow rather rapidly, 29 to 60 mm. in 10 to 12 days at 25° C, with surface usually radially furrowed; the other characters are as described above.

"These strains are separable into three types on the basis of typical colors of conidial areas. Following the classification of Raper and Thom, the first type is suggestive of *P. olivino-viride* or *P. palitans* because of the yellow-green conidial colors; the second type is suggestive of *P. cyclopium* or *P. puberulum* because of the blue-green conidial color; and the third type is suggestive of *P. cyclopium* and the *P. viridicatum* series because of the typical bluish-yellow-green conidial colors. However, all the strains duplicated almost exactly all the characters except color of conidial areas described above.

"These strains differ markedly from *P. puberulum* Bainier, *P. martensii* Biourge, and *P. aurantio-virens* Biourge, primarily in the globose form of the conidia and the typically strongly pigmented surrounding agar in brownish colors.

"They also differ somewhat from *P. viridicatum* Westling primarily in the colors of conidial areas as described above, from *P. olivino-viride* Biourge by the fact that the color of conidial areas changes only

slowly, and in the smooth or nearly so conidial walls, and from *P. palitans* Westling in the colors of conidial areas as described above."

NOTE: "*P. viridicyclopium* Abe is not separable from *P. cyclopium*," G. Smith, Trans. Brit. Mycol. Soc. 46: 332. 1963.

**Penicillium vitale* Pidoplichko and Bilai, in Antibiotic-Producing Microscopic Fungi, V. I. Bilai, p. 44. 1961. Kiev (In Russian).

"Colonies on wort agar are white initially, then greenish-blue, velvety, rather dense and rugose, with a rather broad, white border, during aging they become a greenish-dirty-gray color. The reverse side is at first straw-yellow, then yellowish-cinnamon, yellow along the edges, becoming cinnamon with age. The agar turns green gradually as the culture grows. Numerous yellowish-gold drops usually are formed on the surface of young colonies.

"The mycelium is white. The conidiophores are smooth, 2–3.5μ thick, with penicilli in the form of little bundles with sterigmata at the apex of the conidiophore, single-tiered (usually) or two-tiered. In the latter case the little bundles with sterigmata are found on short branches gathered in verticils of 2–3 on the apex of the conidiophore. The sterigmata are bottle-shaped, 6–8×2–2.5μ, usually by 2 to 5's, in more or less compact bundles. The branches which contain the sterigmata attain a length of 8–10×2–3μ. Sometimes a branch is some distance from the apex of the conidiophore, and then it is frequently longer. The conidia are elliptical or (more often) ovoid when young, 2.5–3×2–2.5μ; then more or less globe-shaped, broadly-elliptical, or round-ovoid; 2.5–4.4μ, in mass 2.6–3μ, smooth, colorless, green in mass, and appear in separate or intertwined chains.

"The temperature for maximum growth on wort agar is 37 to 38°.

"Colonies on Czapek's agar with gelatin (15%) and glucose grow more slowly, greenish-blue, with green shades predominating, velvety, with a rather wide white edge, usually with numerous yellowish-gold drops in the conidial zone, later on becoming a dirty gray color, olive-cinnamon on the reverse side; darkening later on. The gelatin is colored olive and hardly liquifies. The gelatin begins to liquify during the second week of culture growth (at 23 to 25°).

"The liquified gelatin has an alkaline reaction. Colonies on Czapek's agar with sucrose are white at first, then green-blue, velvety, with rather wide white edges, later on becoming dirty gray. The reverse side is straw-yellow at first, then yellow-cinnamon. The agar gradually change to a green color. Drops are abundant, usually on surface of young colonies, yellowish."

(Translated from the Russian by J. O. Legg.)

**Penicillium yezoense* Hanzawa apud Sasaki and Nakane (as "*yezoensum*"), Jour. Agr. Chem. Soc. Japan 18:774. 1943.

"Colonies on Czapek's solution-agar spreading, velvety or funiculose, gnaphalium green or pea green (Rdg., XLVII, 29''''), then

changes to light pinkish cinnamon (Rdg., XXIX, 15″) with sclerotia-production from central area, droplets abundant, reverse cream-buff or chamois (Rdg., XXX, 19″) to light mineral gray (Rdg., XLVII, 25″″), gradually tinged with pink, zonate in age; conidiophores 120–200μ×2.5–3μ unbranched, dilated to 4.5–6μ at the apex and bearing a verticil of 7 to 9 sterigmata 10 to 12 by 3–3.5μ; conidia in chains parallel to loosely columnar in arrangement, 2.5–3.5 by 2–2.5μ, ellipsoid, thin walled, faintly spinulose; sclerotia salmon, subglobose, 100–300μ in diameter.

"Growth in Koji extract-gelatin abundant, rugose, vinaceous cinnamon to light congo pink (Rdg., XXVIII, 7″) with sclerotia, reverse naples yellow to bister (Rdg., XXIX, 15″), substratum changes to brownish, gelatin not liquefied.

"Growth on potato poor, flat and velvety, white, substratum colored.

"Milk peptonized, changes to reddish brown then yellow-brown, litmus changes to blue."

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